SEMI-ANNOTATED BIBLIOGRAPHY OF RESEARCH IN POST-HARVEST TECHNOLOGY FOR CEREAL GRAINS AND GRAIN LEGUMES IN AFRICAN COUNTRIES NORTH OF THE EQUATOR

By

W. D. Rolston

For

International Development Research Centre
Ottawa
Canada

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PREFACE

This semi-annotated bibliography represents an attempt to bring together a comprehensive collection of the research done in the area of post-harvest technology for cereal grains and grain legumes in African countries north of the equator. It was compiled as a supportive document to the International Development Research Centre Mission to Africa, organised to assess the research policies, directions and capabilities of selected, representative countries and to identify the gaps in knowledge concerning the Post-Harvest System.

To bring this immense field within manageable limits, parameters were established as to the countries, crops, and extent of the Post-Harvest System to be considered. For the purpose of this publication, Post-Harvest Technology includes the operations of: harvesting, conditioning, storage, marketing, processing, utilisation, and the corresponding facilitating structures and organisations for sorghum, millet, maize, teff, cowpeas and other common grain legumes. The countries reviewed all contain a semi-arid or a savannah ecological zone. Specifically, they are: Algeria, Cameroun, Chad, Dahomey, Ethiopia, Gambia, Ghana, Guinea, Kenya, Libya, Mali, Maurítania, Niger, Nigeria, Senegal, Somalia, Sudan, Tanzania, Togo, Uganda, and Upper Volta.

This publication is not a complete collection of the available results of the research into post-harvest systems; however, most of the major studies have been included, as well as many of the minor works. Emphasis has been placed on studies done within the countries themselves, but a considerable amount of relevant research done outside of Africa has also been included.

Some comments on the system of classification of articles and general organisation may prove helpful in using this bibliography. The Post-Harvest System has been divided into the sub-system headings: harvesting, storage, marketing and utilisation, which have been replicated under each of three major section headings: "Millet and Sorghum", "Maize", and "Cowpeas and Others." The "Millet and Sorghum" section includes any article which makes reference to one of these two grains, even though the study may also deal with maize or some grain legume as well. If a particular study deals with two or more major sub-systems, it has been placed in the first sub-section, "Post-Harvest Systems." Many articles touch on more than one sub-system, but place a definite emphasis on only one. In such a case, the publication has been categorised according to the sub-system receiving the emphasis. Circumstances, particularly available time, determined which articles were abstracted and which were listed only as titles; therefore, an accompanying abstract does not necessarily signify any measure of importance to the study. The area of consumption and nutrition of cereal grains has been consciously avoided, except where inclusion of such a work illuminates the methods of utilisation.

University and government publications are generally listed under the corresponding country, rather than the institutional name. A study which deals strictly with tests of chemical insecticides has been listed under the outline heading "Protection", whereas, a study which incorporates some aspect of structural or environmental influence, as well as the effectiveness of chemical protectants, has been listed under the heading "General" storage. Any FAO publication classified as an "internal report" is restricted from general distribution. And finally, the word "file" following some of the titles, refers to the Tropical Stored Products Centre, Slough, U.K. file of documents and is more than likely an unpublished report.

It is hoped that this bibliography will be of some value to governments, research organisations, and scientists as a guide to the work which has been done in the field of post-harvest technology of cereal grains in Africa, and also as an indication as to where the gaps in knowledge exist. This bibliography may also prove to be useful in research programme planning through assisting in the identification of similarities in problems of post-harvest technology shared by African countries, and for which co-operative research may be possible, or at least, through helping to prevent unnecessary duplication of research.

Throughout the course of gathering the material for this bibliography, the compiler met with the utmost co-operation from all institutions and individuals contacted. Especially, he would like to acknowledge the generous and valuable assistance of: E.A. Asselbergs, FAO, Rome; R. Britton, University of Manitoba, Canada; R.P. Chatelanat, FAO, Rome; G.C. Corbett, FAO, Rome; H. Creupelandt, FAO, Rome; P. Faure, FAO, Rome; R.S. Forrest, IDRC, Canada; A. Hamilton, CUSO, Canada; IDRC Library Staff, Canada; B.M. Jellema, IITA Staff, Nigeria; Mrs. A. Mackie, Nigeria; F.V. MacHardy, University of Alberta, Canada; H.A.B. Parpia, FAO, Rome; J.E. Reyntjens, FAO, Rome; C. Schneider, FAO, Rome; H. Schwob, FAO, Dakar; H.R. Shuyler, FAO, Rome; R. Sinha, CDA, Canada; Tropical Products Institute Library Staff, London; G. Von Haelst, WFP, Rome; and P. Wheatley and Staff of the Tropical Stored Products Centre, U.K.

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W.D. Rolston

CONTENTS

ABBREVIATIONS

Abst.....Abstracts
Afr.....Africa or African
Agr. or Agric.....Agriculture or Agricultural
Am. or Amr.....American
Anal.....Analysis
Ann.....Annual

Bot.....Botany or Botanical
Bull. or Bul.....Bulletin

Chem.....Chemical
Comp. fl.....Composite flour
Comm.....Commission
Comwth.....Commonwealth
Con. or Conf.....Conference
C/P.....Cowpea

Dep. or Dept.....Department
Dev.....Development
Div.....Division

E.....East or Eastern
Econ.....Economic
EDB.....Ethylene dibromide

Fed.....Federal
Fd.....Food
For.....Forestry

G/C.....Guinea corn
HCN.....Cyanic acid
Hort.....Horticulture or horticultural

Inst. or Ins.....Institute
IAR.....Institute for Agricultural Research
IDRC.....International Development Research Centre
J.....Journal
Leg.....Legume(s)

Manuf.....Manufacture or manufacturing
Mkt.....Market, marketing or markets
MeBr.....Methyl bromide
M. or Min.....Ministry
Misc.....Miscellaneous
M/C.....Moisture content

Nig.....Nigerian
N.....North or northern
No.....Number
Org. or Organ.....Organisation

PHT.....Post-harvest technology
Proc.....Proceedings
Prod.....Product(s)
Pub. or Publ.....Publication

R/H.....Relative humidity
Rep. or Rpt.....Report
Res.....Research
Rur.....Rural

Soc.....Social or Society
Sorg.....Sorghum
S.....South or southern
Stat.....Station or Statistics
Stn.....Station
St. or Stor.....Stored
St. or Stud.....Study or Studies

Tech.....Technology or Technical
TPI.....Tropical Products Institute
Trop.....Tropical
TSPC.....Tropical Stored Products Centre
TSP Info.....Tropical Stored Products Information

W.....West or western

I. BIBLIOGRAPHIES, INDEXES, etc.

1. General

- BRASSEUR, P., 1964, General Bibliography of the Mali Republic; Formerly the French Sudan and Upper Senegal-Niger. Dakar, Inst. Français Afrique Noir, 461 pp.

- CHANT, J.F., Bibliography of Recent Farm System Studies in Tanzania. ERB Paper No. 68.2.

- FARIS, D.G., 1967, A Bibliography of Cowpeas. Samaru Misc. Paper No. 22, IAR, Nigeria, 105 pp.

- NIGERIA, 1969, Index of Agricultural Research and Related Subjects in Nigeria, 1968-69. Ibadan, Fed. Dept. Agric. Res., VII, 144 pp.

- ROCKEFELLER FOUNDATION, 1961, Bibliography of World Literature on Pennisetums, 1935-61.
  - also - Bibliography of World Literature on Small Millets, 1935-61.

- U.S., 1967, The Millets - A Bibliography of the World Literature covering the Years 1930-63. George Washington Univ., The Scarecrow Press Inc.
  - also - Sorghum - A Bibliography of the World Literature covering the Years: Vol. I - 1930-63 and Vol. II - 1963-67. - from same Institute.

2. Storage

- BLATCHFORD, S.M. and WYE, A.J., 1971, Crop Storage Bibliography (with Particular Reference to the Storage of Durable Agricultural Produce in Tropical and Sub-Tropical Countries). Trop. Prod. Inst., Publ. G-64, 12 pp.

- GARGH, M.C., 1974, A Literature Review on the Movement of Moisture in Cereal Grains. Int. Rep., TSPC, Struct. Hand. Meth. Sect. No. 7.

- PEST INFESTATION CONTROL LABORATORY, 1973, List of Papers Published in Scientific and Technical Journals (including Papers by the Staff of the Trop. Stor. Prod. Cen.), Slough, Min. Agric., Fish and Fd., 79 pp., 866 references.

- TROP. STOR. PROD. CEN., 1969, Food Storage Bibliography (with special reference to Tropical Foods)., Slough, Min. Overseas Dev., 9pp.

- TROP. STOR. PROD. CEN., Specialised Courses and Advisory Section, 1972, Underground Storage of Crops - A selected Bibliography. Trop. Stor. Prod. Info. (23), 45-46.

- U.K., 1973, Economics of Centralised Grain Storage (1968-1972). Annotated Bibliography, No. 20, Commwth. Bur. Agric. Econ., pp. 6.

- WARD, N. and CALVERLY, D.J.B., 1972, A Literature Survey on the Climate Relationships in Stores. Trop. Stor. Prod. Info. (23), 35-44.

- WYE, A.J., 1971, Selected Bibliography on Improving Farm Storage. Trop. Stor. Prod. Info. (21), 13-17.

3. Marketing

- ILLY, H.F. and GABELMANN, E., 1970, Bibliography of the Co-operative Movement in Cameroon. Douala Inst. Pan-African Dev., 12 pp.

- U.K., Commwth. Bur. Agric. Econ., 1971, The Marketing of Agricultural Produce in West African Countries, with Special Reference to Ghana. An Annotated Bibliography. Oxford, No. 2, 6 pp.

4. Utilisation

- FAO, Food and Agric. Ind., 1970, Annotated Bibliography. Rome, 199 pp. plus subject and author indexes.

- TROP. PROD. INST., 1972, Composite Flours. Bibliography, Publ. G-71.

II. MILLET AND SORGHUM

A. Post-Harvest Systems

- ACKELS, A.A., et al, 1970, A Study and Plan for Regional Grain Stabilisation in West Africa, contract AID/csd-1588, 224 pp.

  The study covered three countries; Mali, Upper Volta and Senegal, with the purpose of making recommendations on food grain drying, storage handling and transportation. After a general introduction to the country, its economy, agriculture and grain trade, extensive tables and charts present the research team's findings on such things as commodity prices and price fluctuations, transportation rates, maps of routes for transport, handling costs, storage facilities, etc. Not every item is presented for each country. Following this basic data is an analysis, which includes market structures, cereal grain standards, storage, pricing policy, etc. Recommendations are made at the end of each country section and a final section deals with general recommendations for regional grain stabilisation.

- ACLAND, J.C., 1971, East African Crops. An Introduction to the Production of Field and Plantation Crops in Kenya, Tanzania and Uganda., FAO.

  A book of 36 chapters, each covering one crop, including: beans, bulrush millet, cow peas, finger millet, maize, pigeon peas and sorghum. Each chapter includes an introduction and description of plant characteristics, ecology, varieties, field operations, harvesting, yield, pests, diseases and utilisation for the particular crop under consideration.

- L'AGRONOMIE TROPICALE, Review of IRAT work in Africa. Vol. 25 (10 & 11) 905-.

- BERNARD, F.E., 1972, East of Mount Kenya: Meru Agriculture in Transition, Afrika-Studien, IFO-Institut fur Wirtschaftsforschung, Munchen, No. 75, 176 pp.

  This lengthy study examines the changes that have occurred in Meru District agriculture since pre-European days. Improved markets and roads are seen as necessary prerequisites to the intense changes that began after 1955. The impact of the many changes since the 50's are examined in detail. One of the chief problems hampering agriculture in the area today is the inefficient flow of grain through market channels.

- BONLIEU, A, 1962, Animal-Drawn Equipment -- Treatment of Crops in Senegal. CCTA/FAO Symposium on Stored Food, Freetown, 20-24 Feb., 1962.

  Parts I and II of the paper consider prevailing conditions in Senegal and potential for using animal-drawn equipment on medium sized farms. Part III deals with processing after harvesting of groundnuts and millet. At present, millet is stored on the head, but would store better as threshed grain. A design for a millet thresher suitable for village and co-op. use is given. An experiment with two-ton capacity storage silos is outlined. The silos were built of corrugated sheets assembled by villagers and erected on mud floors impregnated with insecticide, or on cement or mud floors impregnated with sump oil. Roofs were of flat galvanized iron sheeting or tar-lined paper. Grain should be mixed in the silo with lindane or malathion. Mention is also made of a French-manufactured millet mill which removes millet hulls without wetting and produces a flour which will keep up to three months.

- BONLIEU, A., 1962, Traitement après Récolte des Produits Vivriers: mil, sorgho, niebes, doliques. U.N.E./Conf., 39/C/64, 26 Sept., 1962.

- BROSS, H., 1964, Grain Study, Somalia, East Africa., USOM.

- BURKE, R., VANDERMEULEN, H., & WEIJS, H., 1971, Rapport Concernant Les Produits Vivriers au Niger. Hedlin Menzies & Assoc. Ltd., for CIDA, 117 pp.

- BYZDRA, T., 1974, Culture, Storage, Trade and Milling of Cereals in Ancient Egypt. Przegl. Zboz. Mlyn. 18 (2), 29-31.

- CHECCHI AND CO., 1970, Food Grain Production and Marketing in West Africa., Wash. AID Contract No. AID/AFR. - 664, 87 pp.

  The report contains a general summary of the current agricultural and economic situation in four countries of West Africa: Mali, Niger, Senegal and Upper Volta. It reviews and makes recommendations for future direction in eight problem areas, including agricultural markets, economic analysis and agricultural extension. The last section gives detailed country reviews for the four countries. Mali is the only one with a national marketing system for food grains (OPAM). For each country a description is given of the agricultural marketing system for all agricultural produce and discussions of periodic food shortages. This is followed by recommendations for improvements in these areas. A reference list is included.

- DOGGETT, H., 1967, Sorghum in East Africa. Sols Afr., 12 (2 & 3) 115.

- EICHER, C.K., 1970, Research on Agricultural Development in Five English-Speaking Countries in West Africa. New York: Agricultural Development Council Inc., 153 pp.

  Agricultural development in Gambia, Ghana, Liberia, Nigeria and Sierra Leone are discussed in Part I of the study. Part II attempts to define the nature of agricultural development from an interdisciplinary study in Nigeria, to assess research on rural development in West Africa between 1950 and 1960 and to identify gaps in the research and priority research areas.

- FAO, MARKETING DIVISION, 1965, Marketing of Staple Food Crops in Africa, Report on the First FAO Training Centre on the Marketing of Staple Food Crops for African Countries, Nairobi, Kenya, Aug. 1964.

  The information contained in this publication was obtained from a wide variety of sources and covers most of the marketing chain from production figures and factors affecting the market supply and consumer demand, followed by a discussion of different pricing practices (weights, measures and quality) and price variations between regions and between seasons and years. Methods and use of transport facilities for staple foods in various countries are described, storage facilities and recommendations for improvement are presented and a theoretical discussion on introducing improved processing techniques is given. Annex II gives in tabular form, the present techniques of food processing by commodity, including: costs, capacity, extraction rates and general economics of each system. The publication ends with a discussion of several aspects of market organisations and services, including: marketing boards, co-operatives, marketing margins, marketing training and extension, etc.

- FAO/ITA, 1970, Economic Aspects of the Food Crops Problem (Short-Term Prospects). Rep. to the Govt. Senegal, FAO Tech. Rep. No. 1, 55 pp.

- FAO, 1973, Agricultural Mechanization Research in West Africa, Country reports. AGS: MISC/73/11, 159 pp.

- FORREST, R.S., PETERSEN, T.A., ET AL, 1975, The Post-Harvest Food Grain Industry in Semi-Arid Africa, Appendix B, report of a mission to six African countries. IDRC, Canada.

- HARRISON CHURCH' R.J., 1961, The Islamic Republic of Mauritania. Focus 12, (3).

- HOWE INTERNATIONAL LTD., 1972, Master Plan Study for Handling, Storage and Marketing of Grain Produce., 181 pp.

  The study examines the present state of storage and post-harvest loss, transportation and marketing procedures for wheat, dura and dukhn in order to propose a plan for an integrated storage system to aid price stabilisation, buffer stock buildups and general improvement of the agricultural economy of the Sudan. Each of the areas, waste and loss of grain, storage facilities, transportation (river, road and rail), and market systems is examined and evaluated. Transport was found to be the most serious problem in the economy and a good deal of emphasis is placed on it in the proposals. Recommendations are made as to types of storage facilities and locations, transportation requirements and marketing controls needed including establishment of a Sudan Grain Board and Sudan Grain Commission. Cost estimates are included.

- HUFFNAGEL, H.P., 1961, Agriculture in Ethiopia. FAO, Rome, 484 pp.

  This publication is a compilation of work done by FAO personnel in Ethiopia in recent years. It includes discussions on, among other things, economic conditions, agricultural practices, marketing and processing, and agricultural services and institutions.

- I.T.A., Dakar, 1970, Lectures on Grain Conservation, Processing and Storage, Senegal., AGS--UNDP/SF SEN 5, Rep. No. 58, 100 pp.

- INTERNATIONAL DEVELOPMENT RESEARCH CENTRE, 1973, Consumer Food Utilisation in the Semi-Arid Tropics of Africa. Report of an interdisciplinary workshop, 16 pp. and microfiche.

- IRVINE, F.R., 1969, West African Crops. Vol. 2, Oxford Univ. Press.

  The book is divided into six sections, each dealing with one of: cash crops, fruits, vegetables, cereals, root crops and legumes in West African traditional agriculture. The cereal section includes, among others: Maize, guinea corn and millet. Short descriptions of the varieties, environment, cultivation practices (including harvesting), yields, traditional storage methods and common diseases and pests associated with the crop are given. Local uses of the grains and vegetative plant parts are also briefly reviewed. The final two sections present short descriptions of general husbandry practices and a review of common plant diseases and insect pests.

- JACKSON, R.T., et al, 1969, Report of the Oxford University Expedition to the Gamu Highlands, Oxford: School of Geography, 112 pp.

  A detailed examination of the intensively cultivated areas of the Gamu Highlands in Ethiopia is reported on. Descriptions of cultivation techniques, sources of income and reasons behind the present agro-economic situation are given. Marketing appears to be poorly developed, as no cash cropping is done. Traders handle all commodity flows between markets, which, in general, appears to be a very localized enterprise. Methods of cultivation, pests and storage are described in Ch. II. Detailed case studies of two districts are given in Ch. III and IV, and Ch. V discusses all aspects of local marketing, interregional and extraregional trade.

- JELLEMA, B.M., 1973, Improvement of Cereal Production and Marketing in the Central African Region, IITA, Ibadan, 81pp.

  The report is in four sections, one devoted to each of: Cameroons, Chad, Central African Republic and Gabon. Maize, sorghum and millet, being the most important staple foods, are concentrated on, but rice and wheat receive attention also. The study examines for each country and crop, the marketing channels, price fluctuations and their differences over time and space, storage practices and facilities, transport facilities and interprets each of their effects on the staple food economy. The author finds that only small percentages of produce enter market channels and that prices and quantities in the markets fluctuate greatly. He feels that any increase in production over population increases at this point in time will adversely affect prices and farmer income. High storage losses (particularly for maize), mainly at the trader level, occur. He feels there is a high potential for increasing maize production in the Cameroon highlands, but that demand will have to be increased by the feeding of poultry. He notes the commercial use of grains in feed mills and breweries. Recommendations are made for co-ordinating administrative bodies dealing with increasing production of various crops and suggest that storage and transport must be improved.

- JOHNSTON, B.F., 1958, The Staple Food Economies of Western Tropical Africa. Food Res. Inst., Stanford Univ. Press, 305 pp.

  The book provides an overview of the staple food economies of the western region of tropical Africa. The first part of the publication gives a general description of the climates, characteristics of the staple crops and their geographic distribution. A short section dealing with trade of staple foodstuffs, internally and between countries, is also presented. The second part deals with factors influencing the distribution of staples: economic factors of supply and demand, social influences, and the introduction of new crops, such as rice and maize. Traditional methods of preparing staple foods are described as well as seasonal consumption cycles and the effect of wheat imports. Some of the problems of increasing the staple food supply, such as, transport, storage facilities, and organised marketing are briefly examined.

- LANDERBER, 1969, "Togo". Statist. Bundesamt., Wiesbaden, 1969, pp 1-92.

  This publication presents a description of the demography, socio-economic situation and economic structure of Togo. Subject areas dealt with include: agricultural production, industry, trade, transport and communications. Statistical data is provided.

- LEAKEY, C.L.A., 1971, Factors Affecting Increased Production and Marketing of Food Crops in Uganda. East African J. Rural Development, 4 (2) 1-20.

  A wide range of topics is discussed, including: types of research, traditional agricultural systems in East Africa, modern agriculture as it relates to peasant practices (reintroduction of mixed cropping), technical factors of increasing production (pest and disease control), marketing and prices, agricultural credit and food storage.

- MEYER, P., 1965, An Inquiry into the Market of Dahomey. Marchés Trop. Méditerreanées, Paris, 21 (1046) 2977-3038.

  This fairly extensive study includes information on: the economic situation of Dehomey, transport, marketing and storage of agricultural goods and legislation on the establishing of foreign industry and commercial enterprises.

- MURDOCH, G.P., 1960, Staple Subsistence Crops of Africa. The Geographical Review, 50 (4).

- NIGER, 1961-62, Les Produits Vivriers au Niger, Production et Commercialisation (étude générale) I. Mils et Sorghos.

- PARPIA, H.A.B., 1969, Waste and the Protein Gap - They can Both be Reduced. Ceres, 2 (5) 20-24.

- PARPIA, H.A.B., 1974, The Impact of Food Conservation and Processing Industry on Nutrition., FAO-prepared for A Study of Child Nutrition in Developing Countries, for 1975, UNICEF, New York, 49 pp.

- REICHHOLD, W., 1964, The Islamic Republic of Mauritania. Lander Afritras 28 pp. 94, Bonn: Schroeder.

- RUTHENBERG, H., 1964, Agricultural Development in Tanganyika. Berlin: Springer Verl. - IFO - Inst. Wirtschaftsforschung, Munchen, Afrika-Studien, No. 2, 212 pp.

  This lengthy study presents a history of agricultural development in Tanzania, including experiences gained under the British administration and assesses the present situation concerning encouragement of peasant agriculture. It makes a number of recommendations toward development aid, including among others, investment in industries to process agricultural raw materials and thereby improve marketing conditions and to encourage extension training and applied research.

- SABATINI, O. & SAMUEL, L.N., 1969, A Survey of Agriculture in Ethiopia. USDA, Econ. Res. Service, No. ERS-Foreign 254, 44 pp.

  A general review of agro-economic development in Ethiopia and examination of export and imports of agricultural commodities, primarily with the U.S., is given. Some discussion of problems in traditional farming practices, inadequate transport and marketing systems is presented also. Governmental plans for improving and developing the agricultural sector, including agro-industries, are reviewed.

- SHAW, D.J. (Ed) 1966, Agricultural Development in the Sudan. Khartoum: Philosophical Soc. Sudan in conjunction with Sudan Agric. Soc., Vols. 1 & 2, 171 & 494 pp.

  The proceedings of an agricultural development conference for the Sudan, held in Khartoum from Dec. 3 through 6, 1966, are presented. The two volumes contain 49 reports, background papers and other papers dealing with, among others: agricultural marketing, mechanisation and programmes of research, extension and training.

- SIMOONS, F., 1960, Northwest Ethiopia, Peoples and Economy. Univ. of Wisconsin Press, 215 pp.

  The emphasis of this fairly comprehensive book is on agricultural practices and alternative means of livelihood. Initial chapters give a review of the history, peoples, social and political organisation. The fifth chapter deals with crop cultivation practices including: harvesting, threshing, winnowing and storage. Chapter 9 deals with the food and cooking practices and Chapter 11 with marketing past and present, both in and outside the area.

- SPENSLEY, P.C., 1973, Improving Post-Harvest Technology. Appropriate Technology Conference, Univ. of Edinburgh.

- TOURTE, R., NICOU, R., & BONLIEU, A., 1963, Traitement après Récolte des Mils et Sorghos, Agron. Trop. 18 (1) 73-81.

  A description of local harvesting, storage and milling procedures for millet and sorghum in Senegal is given. Approximately 56.5% of milled grain becomes flour. A prototype thresher developed at Bambey Research Station is noted. Experiments on silo storage and fumigation of millet and sorghum are discussed. Comparisons were made between small corrugated iron silos, standing on cement or packed earth, and bag storage methods with lindagrain and Bromodan insecticides. Larger silos were also tried using lindagrain and Sumitox. Some of the problems encountered are discussed. Costs of storage and insecticides are given. A description of the local milling techniques is reported. About 50% of the people use a mixture of millet and sorghum which presents problems due to the different sized kernels. The authors assert that millet flour will keep up to three months with no flavour change.

- WARREN, 1962, The Agricultural Economy of the Sudan. USDA, Foreign Econ. Res. Service, No. 26, 28 pp.

  The report describes principal crops, irrigation methods, transportation, trade with the U.S. and other aspects of Sudanese Agriculture.

- WEITZ-HETTELSATER ENGINEERING & PORTER INTERNATIONAL CO., 1969, A Grain Stabilisation Study of The Entente States and Ghana, 385 pp.

  The primary purpose of this lengthy study was to develop a grain stabilisation plan for the Entente States (Dahomey, Ivory Coast, Niger, Togo, Upper Volta) and Ghana, using a systems approach. In so doing, it devotes the first six

chapters (148 pp.) primarily to a review of the present situation and noting where improvements could be made. Each subject area is covered country by country and often by commodity as well. Subject sections reviewed include: Production figures, transportation facilities, agricultural credit, the grain marketing systems, grain storage and processing facilities (including a general discussion of the "Sotramil" at Zinder), and present grain stabilisation agencies. The second part of the study deals with the plan for grain stabilisation, including detailed outlining of simultaneous buffer stock reserve programmes and national grain storage facilities.

B. Harvesting and Conditioning

1. Traditional

- BARBOT, J., 1725, A Description of the Coasts of North and South Guinea and of Ethiopia Inferior, Vulgarly Angola. In A. Churchill comp. A Collection of Voyages and Travels, Vol. 5.

- BURLEY, R.H., ed., 1957, The Agriculture of Ethiopia. U.S.A. Operations Mission to Ethiopia-Point 4, Vol. 2, Addis Ababa.

- CAHIERS AGRIC. PRAT. PAYS CHAUD, 1968, Cultivation-Senegal. No. 3, 133-50.

- CATHERINET, et al, 1962, Millet and Sorghum in the Agriculture of Niger, CCTA/FAO Symposium of Savannah Zone Cereals: Dakar, 28/8-4/9.

- CONKLIN, H.C., 1963, The Study of Shifting Cultivation, Washington.

- DOGGETT, H., et al, 1968, Sorghum and Millet. A reprint from Ann. Rep. East African Agric. and Forestry Res. Organ.

- DUMONT, S., 1966, Cultivation - Niger. Agron. Trop. 21 (8) 883.

- FAO, 1960, Technical Conversion Factors for Agricultural Commodities.

  Nigeria -- threshed grain yield of unthreshed grain is 70% for sorghum.

- FAULKNER, O.T. & MACKIE, J.R., 1933, West African Agriculture. Cambridge, England.

- GAST, M., 1972, Céréales et Pseudo-céréales de Cueillitte du Sahara Central (Ahaggar). J. d'Agric. Trop. et de Botanique Appliquee, 19 (1-2-3) 50-53.

- HARLAN, J.R. & PASQUEREAU, J., 1969, Décrue Agriculture in Mali. Economic Botany 23 (1) 70.

  The authors describe the agricultural systems of sorghum and millets planted on seasonally flooding lands after the flood has receded. They describe the hydrology, crops, and varieties grown, cultural practices, and end with storage and utilisation. Pearl millet is harvested by cutting the head with a hand knife and either tying the heads into bundles or storing in temporary granaries for later threshing. A wooden mortar and pestle is used for threshing and after cleaning and winnowing, also for rough cracking for cous-cous or porridge. Some flour is made using hand operated grinding stones. These tasks are the work of women and children. Sorghum is harvested similarly, but threshing involves use of long flail sticks and is often a community affair for the men. The durra sorghums are very susceptible to insect attack in storage and keep better unthreshed. They are usually eaten first before the hard seeded guinea corn, which can be stored, threshed, for up to two years. Wooden mortars are used in the preparation of sorghum also. Durras, being easily cracked, are prepared in larger quantities than the hard, tough to prepare, guinea corns each meal. Guinea corns are considered more nutritious and are preferred over durras when heavy field work is in progress. The authors believe that generally throughout West Africa, white sorghums are used for food and red ones for beer. In strict Muslim areas, where beer is forbidden, little of the red varieties are grown. A sweet-stalk variety is sometimes grown in small patches around villages and used for chewing.

- McLOUGHLIN, P.F.M. (ed.), 1969, African Food Production Systems. Cases and Theory., John Hopkins Press, London, 318 pp.

  Detailed case studies of traditional food production systems in Tanzania, Uganda, Sudan, Zaire, Central African Republic, Sierra Leone and Senegal are presented. Several other studies are included, amongst them: food economy in a rural village of Mali and an evaluation of a mechanisation attempt in Gambia. The introduction and conclusion deal with development theory and an assessment of past development lessons, respectively.

- NABOS, J., 1967, Brief Report on Millet and Sorghum in the Niger Republic. Sols Afric. 12 (2 & 3) 199.

- NIGER, 1954, Niger - Harvesting Methods. Archives de l'Offic du Niger, No. 7, pp. 45-46.

- OCHSE, J.J., et al, 1961, Tropical and Sub-Tropical Agriculture. Macmillan Co., New Zealand.

- PINTO, F.F., 1969, Cereals in Perspective in Ethiopia. FAO Near East Wheat and Barley Improved Production Project, Info. Bull. 6 (3) 7-16.

  Information is presented on area, production, distribution, production methods and varieties of some cereals, including teff, sorghum, maize and millet. Discussions of present and proposed research projects are given.

- ROUNCE, N.V., KING, J.G.M., & THORTON, D., A Record of Investigations and Observations on the Agriculture of the Cultivation Steppe of Sukuma and Nyamwezi. Tanganyika Dept. of Agric., Pamphlet No. 30, Dar es Salaam.

- RUSSELL, E.R., 1940, Primitive Farming in Nigeria: the Munuye Tribe. Empire J. Exp. Agric., Vol. 8.

- SOLS AFRIQ., 1967, Cultivation in Senegal. Vol. 12 (2 & 3) 213-218.

2. Improved

- AN. SITUACION AGRIC. SINALOA, 1970, Assessment of Sorghum Crop Losses in Threshing in the Irrigation Districts. 8 (68) 311-320.

The report discusses a sample survey of grain losses from combine harvesting of sorghum in Sinaloa, Mexico. It was found that the large losses occurring (up to 980 kg/ha on smaller farms) were due to a lack of expertise on the part of the farmers in the operation of the harvesters. The report also states that proper harvest timing will help reduce grain losses.

- BEEKMAN, E. & RAY, L.R., 1951, Equipment for Cleaning and Grading Grains and Seeds. FAO Agric. Devl. Paper No. 10, 17 pp.

- CASWELL, G.H., 1973, Drying Grain. Typed notes, 3 pp.

- HELLEINER, G.K., 1968, Mechanisation in East Africa Agriculture, Agricultural Planning in East Africa. Nairobi, East Africa Publishing House, pp. 81-115.

- IRAT, SENEGAL, 1973, Présentation de la Batteuse à Mil (Pennisetum). Centre National de Recherches Agronomique de Bambey.

- JOHN DEERE & CO., 1970, International Conference on Mechanized Dryland Farming, 1969. John Deere Co., Mobile, Ill., - FAO joint-sponsored.

- KENYA FARMER, 1957, Grain Drying. Nov./Dec., pp. 16.

Very short article describing portable grain dryer for use on bagged grain. Air, warmed by propane or electricity is forced through up to 10 perforated "spears" stuck into the sack of grain. Moisture reduction was 1.6% per hour with 10 sacks.

- KLINE, C.K., et al, 1969, Agricultural Mechanization in Equatorial Africa. Institute of International Agriculture, East Lansing, Michigan, Michigan State Univ. Report No. 6.

A very comprehensive book dealing with mechanisation of agriculture through hand tools, animal implements and engine power. Part I consists of the summary and recommendations on national and private mechanisation programmes, training centres and research requirements. Part II forms the main body of the study. A description of present mechanised farming systems is presented through examination of case studies in various African countries. Engineering and technical analyses of production operations, including harvesting, threshing, handling and transportation are given. Economic analyses are done on hand, animal and engine powered agricultural systems. The introduction of improvements into each system is considered. Part III consists of an extensive bibliography.

- MADHAVA, R. & GOUDA, S., 1965, Threshability in Hybrid Sorghums. Sorghum Newsletter (8) 30.

- MUCKLE, T.B. & STIRLING, H.G., 1971, Review of the Drying of Cereals and Legumes in the Tropics. Tropical Stored Products Information (22) 11-29.

The article outlines the relationships between moisture, the grain and the environment and defines limits for safe storage. Post-harvest drying becomes necessary, at times, to bring the moisture level of grains to within these limits. The authors describe methods of natural and artificial drying and of the operation of artificial dryers (low, medium and high temperature). Advantages, limitations and performance ratings are given for different dryer systems and their operation is outlined. Maize, rice, groundnuts, peas and beans are discussed individually, as each has its own special requirements.

- OPTIONS MEDITERRANEENNES, 1970, Mechanisation of Agriculture, Paris, (4) 13-122.

This entire issue of Options Mediterranéennes is given to agricultural mechanisation. A large number of articles are included, covering areas such as: the value of mechanisation in developing countries, case study examples of the effects of, or considerations necessary in, mechanising agriculture in mediterranean countries. One article is devoted to harvesting.

- PANESAR, B.G. & PATHAK, B.S., 1974, Investigations into Mechanics of Rub Threshing. I. Threshing Efficiency and Grain Damage Equipment. J. Agric. Eng. 11 (3), 1-8.

- RABAGO, R., et al, 1969, Determination of the Appropriate Time for Harvesting Grain Sorghum. 1. The Relationship between Grain Humidity and Yield. Rev. Cubana Ciencia Agric. 3 (3) 253-58.

In two sowing-time experiments with hybrid sorghum H610, conducted in Cuba, a quadratic relationship between yield and time of harvest appeared, and in one, a significant relationship between yield and grain moisture content ($Y = -246.1 + 196.0X - 2.857X^2$). In both, optimum yield occurred at 32% moisture content, suggesting a considerable advantage in harvesting sorghum at a moisture content of approximately 30%.

- ROBERTSON, K.E. & MOWRY, G.R., 1963, Solar Heat Aids Grain Drying, Sun at Work, 8 (4) 3-5.

The article describes the equipment and method of operation of a storage bin designed to use solar energy as a supplement to natural air drying of stored sorghum grain in Kansas. Results of a trial comparing natural air to solar supplemented drying are given. The authors conclude that in-storage drying systems, using solar energy, can reduce operational costs over that of natural air drying in Kansas.

- TAHIR, W., 1964, Sorghum Improvement for Mechanised Production in the Central Rainlands of the Sudan. Empire J. Exp. Agric. (32) 212-18.

- VITA, 1970, Village Technology Handbook, Schenectady, New York.

- WEIR, A., 1973, Pedal Drive Units Report. Agric. Eng. Dept., U. of Dar Es Salaam, Morogoro. Mimeographed, 17 pp. plus 16 pp diagram supp.

- WILLCOCKS, T.J., 1969, Animal Drawn Toolbar. Silsoe Overseas Liaison Dept., Nat. Institute of Agric. Engineering, Bull. No. 2.

  The bulletin describes the use of an animal-drawn toolbar for intensifying agriculture in East African countries and discusses the successful introduction of a prototype into Tanzania and Uganda. Various interchangeable equipment enable the toolbar to do primary tillage, seed-bed preparation, weeding, spraying and crop harvesting. The bulletin includes descriptions, illustrations and instructions for assembly and use.

C. General and Farm Storage

1. Traditional

- ADEYEMI, A.O., 1967, Storage Pests of Cereals (Maize, Millet, Guinea Corn) and Their Control in Nigeria. Sols Afr. 12 (2-3) 159-166.

  Reviews literature on traditional methods of storing cereals, and storage pests. Also discusses control methods.

- BONLIEU, R., NICOU, R. & TOURTE, R., 1964, La Conservation des récoltes au Senegal. Essais sur le mil, le sorgho, le paddy, le niebe. Agron. Trop. 19 (1) 744.

- BOXALL, R.A., 1974, Underground Storage of Grain in Harar Province, Ethiopia - Construction of Storage Pits. TSP Info. 28, 39048.

- BUNGUDU, L.M., 1970, The Storage of Farm Products by Farmers in my Village. Samaru Agricultural Newsletter, 12 (1), IAR, Zaria, Nigeria.

- CASWELL, G.H., 1970, Cereal Storage in the Northern States of Nigeria. African Soils, 15 (1-2-3) 465-68.

- CHAMBERS, P.C., et al, 1939, Native methods of Food Storage, East African Agric. J. (5) 99-103.

  In Kenya, the grain, when thoroughly dry after threshing, is stored in "ngitu" (flask-shaped stores made of grass). These stores are plastered inside and out with mud and a cap is sealed on the top. Because sorghum is more liable to insect damage, new storage vessels are necessary each year. Sorghum for seed is kept in pots often mixed with ashes. Sorghum ears are placed in the sun to dry for one or two months. Before the rains, the grain is threshed and put into grass stores in which it may be kept for 6-9 months.

- DARLING, P., 1954, The Storage of Food Grains in the Sudan. Min. Agric. Res. Div., Memoir No. 37.

- DOGGETT, H., & MAJISU, B.N., 1968, Some Problems of Sorghum and Millet Production in Africa. U.S. Nat. Academy of Science, N.R.C. Conference on Agric. Research Priorities for Economic Development in Africa, Abijan, Vol. 2, pp 112.

- DUNBER, A.R., undated, The Annual Crops of Uganda. Publication of East African Literature Bureau, P.O. Box 30022, Nairobi, Kenya.

  A large number of crops are covered, including: finger millet, sorghum, maize, bulrush millet, beans, tepary beans, cow peas, pigeon peas, and chick peas. When available, details for each crop, concerning: other names, uses, characteristics, cultivation, harvesting, packing and storage, pests and diseases, are given. The final chapter reviews storage.

- *GILES, P.H., 1962, The Storage of Guinea Corn and Millet* by Farmers in Northern Nigeria. CCTA/FAO Symposium on Stored Foods, Freetown.

  A description is presented of traditional farmer drying and storage techniques and the temperature and humidity characteristics involved. Insect pests of stored grain (threshed and unthreshed) are listed. The effect of relative humidity on level of damage to grains is described and cross-infestation is noted. Various control measures using insecticides are discussed.

- GILES, P.H., 1963, The Storage of the Cereals, Sorghum, Millet and Maize by Farmers in Northern Nigeria. Report prepared for inclusion in the FAO Handbook - Some Essential Considerations for Storage of Food Grains in Africa.

- GILES, P.H., 1964, The Storage of Cereals by Farmers in Northern Nigeria. Trop. Agric. 41 (3) 197-212.

  The article describes traditional methods and times of harvesting sorghum and millet, the types and methods of storing the grain and length of storage. Methods of insect control used locally are explained and the results of data on sampling from local grain stores is given, including the extent of damage and correlations with length of storage. Temperature observations were also made from two types of granaries and commented on. Moisture studies on threshed and unthreshed sorghum have demonstrated that the possibility of long-term storage without insect damage decreases as rainfall increases and thus, with a decrease in latitude.

- GILMAN, G.A., 1968, Storage Problems in Ethiopia with Special Reference to Deterioration by Fungi. TPI, R 48, 52 pp plus app.

  Fairly detailed descriptions of traditional harvesting and drying methods for maize, sorghum, t'ef, wheat and barley are presented, along with threshing techniques. Because of the varied nature of the geography, generalisa-

tions on the country as a whole could not be made. Descriptions are presented of the common storage methods, both bulk storage (cribs, barns, underground pits and gotteros) and household stores (jute sacks, metal drums, goat skins, and dung containers). The length of time in storage varies from 3-4 months to 5-10 years in different areas. Reasons that farmers sell their grain are assessed through a survey. Reasons varied considerably with the area and proximity to large centres. Grain storage losses are assessed both by quantity and value. One section deals specifically with pit storage, climatic considerations and experimental work and three sections deal with fungal damage, geographical distribution, its effect on different crops and recommendations for control.

- GILMAN, G.A. & BOXALL, R.A., 1974, Storage of Food Grains in Traditional Underground Pits. Trop. Stored Prod. Info. 28, 19-38.

- HOPKINS, J.C.F. & PEARSON, E.O., 1961, Report on Visit to West Africa, Oct. - Nov., 1961, 5 pp.

- JONES, A., 1968, Report on a Visit to Ethiopia on Problems Associated with the Use of Sacks., U.K. Ministry of Overseas Development, unpublished report of the Tropical Stored Products Centre, (TPI).

- NYANTENG, V.K., 1972, The Storage of Foodstuffs in Ghana. Univ. of Ghana, Inst. Stats. Soc. Econ. Res., Tech. Publ. Ser. No. 18, 92 pp.

  Information for the publication was obtained through two questionnaires and interviews with farmers and agricultural officers. The second chapter deals with farmer storage policies, the role of farm storage in production, price and distribution of foodstuffs. Chapter three discusses storage structures and methods in common use for cereals. Chapter four covers storage of non-cereal crops. Storage losses are discussed in the appendices.

- OXLEY, T.A., 1950, Grain Storage in East and Central Africa. Gt. Britain, Colonial Office, Col. Res. Publ. No. 5, London.

- PALES, L., 1957, The Characteristics of Nutrition in Africa. Local Means of Preservation and Storage /case of West Africa. FAO Nut. Meet. Rep. Series, No. 20.

- PARVATHAPPA, H.C., et al, 1972, Comparative Storability and Quality of "Jowar" (Sorghum Vulgare) in Underground and Above-Ground Storage Structures in Villages. Bull. Grain Tech. 10 (1) 25-29.

  Observations were made on sorghum samples stored immediately after threshing in flask shaped underground pits, in "galige" or bamboo bins, in jute bags and in laboratory jars closed with cloth. The underground pits were lined with thick layers of millet or paddy straw. The laboratory samples were incubated for 180 days and at the end showed considerable increase in moisture, free fatty acid, insect count (Sitophilus sp), kernel damage, frass and uric acid and a decrease in viability. Samples in underground pits were examined after 50 and 90 days. S.oryzae

was not found after the first 20 days. The moisture content of sorghum (initially 10-12%), did not change significantly in underground or above-ground storages. Germination and free fatty acids were affected in both, but more so in the underground structure. Insect count, kernel damage and uric acid increased considerably in the above-ground compared to the underground structure. However, there was a uric acid increase in the underground pits, which developed a mouldy, fermented smell.

2. Storage Losses

- ADAMS, J.M., 1973, Storage Loss Assessment Techniques, A Biologist's View, in: The Methodology of Evaluating Grain Storage Losses, a seminar arranged by GASGA, TPI.

- ANDREWS, W.H., 1972, Cereal Grains (With Special Reference to Deterioration After Harvest), Trop. Stored Prod. Centre lecture notes to a four-week course, Sept. 1972.

  After a general coverage of cereal grains, their nutritional, chemical, physical and botanical characteristics, the lecutre series discussed types of deterioration and loss in cereal grains and factors affecting deterioration; agricultural, biological, and post-harvest (including storage).

- CASWELL, G.H., undated, Losses Through Pest and Disease. Typed notes, 2 pp.

- GASGA, 1973, Seminar on the Methodology of Evaluating Grain Storage Losses. Tropical Products Institute, London, 6-7 Feb. 1973, Trop. Stor. Prod. Info. (24) 13-16.

  The article reports on a number of practical aspects to assessing stored grain losses discussed during the seminar, including the reasons and justifications for any particular loss survey, the need to determine what is to be measured and how, survey and sampling methods, sample examination and loss assessment from field data. The main points are summarized in 14 recommendations.

- HAYWARD, L.A.W., 1964, The Trogoderma Problem in West Africa. Appendix B from Rep. of FAO Plant Production and Protection Div., Rome.

- KEITH, M. & HARRIS, E., 1968, Losses of African Grain Sorghum to Pests and Diseases. Pest Art and News Summary, Section A, 14 (1) 48-54.

- NNAC (India), 1967, Report of the Study Group on Food Losses and Their Prevention of the National Nutritional Advisory Council, Gov't of India, unpublished.

- PARKINS, E.A., 1956, Stored Product Entomology (The Assessment and Reduction of Losses Caused by Insects to Stored Foodstuffs). Annual Review of Entomology, (1) 223-240.

- SAI, F., SHIRNAME, T.G., & MAURI, M., 1961, Report to the Gov't of the Somalia Republic on a Survey of Food Shortages.

- U.S. PRESIDENT's SCIENCE ADVISORY COMMITTEE, 1967, The World Food Problem. White House, Wash., D.C., Vol. II, pp. 539-67.

- VENKAT RAO, S., et al, 1958, Effect of Insect Infestation on Stored Grain, III. Studies on Sorghum Vulgare. J. Sci. Fd. Agric. 9 (12) 837-839.

3. Factors Affecting Storage

(i) Biological

- ADEYEMI, S.A., 1968, Storage Entomology, Proc. Agric. Soc. Nigeria (5) 30-34.

  A brief review is given of stored product insects in Nigeria, their infestation characteristics and ecological requirements. Methods of storage control are also listed.

- ATTIA, R. & KAMEL, A.H., 1965, The Fauna of Stored Products in U.A.R. Bull. Soc. Ent. Egypte, 49 221-232.

- BOWDEN, J., 1965, Sorghum Midge and Other Causes of Grain Sorghum Loss in Ghana. Bull. Ent. Res. 56 (1) 169.

- CAMEROUN AGRIC. PASTORAL FORESTIER, 1968, Trogoderma, An African Pest of Stored Foodstuffs. (119) 17-21.

  Short descriptions of the Khapra beetle (Trogoderma granarium and T. versicolor), their life cycles and characteristic damage to stored foodstuffs are given. Methods of control through hygiene and insecticides are outlined.

- CASWELL, G.H., 1975, Grain Storage Problems in Nigeria. Pests, Sitophilus. Samaru Agric. Newsletter 17 (2) 2-3.

- CLARKE, H.J., 1968, Fungi in Stored Products. Trop. Stored Prod. Info. (15), 3-14.

- DAVEY, P.M., 1965, Insect Pests of Stored Products in the Tropics and the Commodities and Conditions in which They Occur. Trop. Stored Prod. Info. (1), 377-386.

- DAVEY, P.M., 1965, The Susceptibility of Sorghum to Attack by the Weevil Sitophilus oryzae (L). Bull. Ent. Res. 56 (2) 287-297.

- DAVIDSON, A., Considerations of Stored Products Entomology in Ethiopia. Unpublished report, Institute for Agric. Research, FAO, Addis Ababa.

- DAVIES, J.C., 1960, Coleoptera Associated with Stored Products in Uganda. East Afr. Agric. J. 25(3) 199-201.

- DEUSE, J., 1967, 1) Sur la Découverte de Plusieurs Foyers de Trogoderma granarium EVERTS au Mali et sur les Mesures Provisoires Préconisees pour Lutter Contre ce Fleau.
  2) Aperçu des Legislations "anti-Trogoderma" Existantes dans les Pays Anglophones d'Afrique et Propositions de Mesures Legislatives Similaires pour l'Afrique Francophone. Rapport IRAT, 52 pp.

- DOGGETT, H., 1963, Sorghum. The Kenya Farmer, No. 87.

  Deterioration occurs in sorghum grain during storage through the attack of the Angoumois grain moth when grain is stored unthreshed and from rice weevils when stored threshed. If the grain has not been properly dried, moulds develop, but this is rare in dry countries. No satisfactory resistance to the grain moth has been found, but some varieties are weevil resistant, specifically, the hard flinty types.

- DOWKER, B.D., 1963, Sorghum and Millet in Machako District. East Afr. Agric. For. J. 29 (1) 52-57.

  The white flinty types of sorghum which best resist weevil damage in store and are most palatable for human consumption are the most susceptible to bird damage. Those brown-grained sorghums which do show a degree of bird resistance are in general much disliked as human food and in addition, store badly.

- EAST AFR. AGRIC. FOR. RES. ORG., 1964, Lepidopterous Pests of Sorghum and Maize. Ann. Rep. 1964, pp. 110, 111.

  Among the Lepidopterus pests found on sorghum and maize was Sitotroga cerealella in the field. These had caused some damage and webbing. The total number of Lepidoptera on bagged and unbagged heads of sorghum indicated that predatory birds were not active during the ten days between samples. The only effect of bagging was to decrease parasitisation.

- ETHIOPIA, IMPERIAL ETHIOPIAN COLLEGE OF AGRIC. and Mech. Arts, undated, Some Agricultural Insects of Ethiopia and Their Control. Exp. Station Bull. No. 23.

- GILES, P.H., 1965, Infestation of Sorghum in Northern Nigerian Granaries. Proc. 12th Int. Congress Ent., London, 1964, pp. 636-37 abst.

- GILES, P.H., 1964, The Insect Infestation of Sorghum stored in Granaries in Northern Nigeria. Bull. Ent. Res. 55 (3) 573-588.

  Records of storage insects in unthreshed sorghum stored in traditional granaries (which are described), throughout Northern Nigeria in 1959-61 are given. The report notes the absence of Sitophilus zeamais except from southernmost areas. The article indicates which pests are important and comments on the incidence and importance of pre-harvest infestation originating from granaries. Increases in damage are most marked 6-9 months after storage, coinciding with rains. Notes also that woven grass granaries are not as good as dried mud ones. Studies with mud granaries and threshed sorghum showed the worst pest to be Sitophilus oryzaeand that damage decreased with depth as did grain moisture content. Insect numbers fluctuated, with a peak during the rains.

- GILES, P.H., 1965, The Insect Infestation of Sorghum Stored in Granaries in Northern Nigeria, Samaru Res. Bull. (57) 573-88.

  The majority of sorghum in Northern Nigeria is stored unthreshed in farmers' granaries made of mud or plant material such as grass matting and cereal stems. It was found that Sitophilus oryzae and Sitotroga cerealella are the main storage pests, but that several others are often found. Some of the insects were already found in sorghum sampled before storage, indicating cross-infestation between fields and granaries. After the harvest in Nov.-Dec., insect populations in granaries remain low until after June, when the moisture content rises in the rainy season. Damage in granaries made of plant materials is usually higher than in mud granaries.

- GILES, P.H., 1965, A Record of Stored Product Insects Associated with Northern Nigerian Foodstuffs. Samaru Misc. Paper No. 8,7 pp., IAR, Nigeria.

- HILL, R.G., 1965, A Preliminary List of the Insect Reference Collections. Imp. Ethipian Coll. Agric. Mech. Arts, Exp. Sta. Misc. Publ. No. 4.

- HOWE, R.W., 1952, Entomological Problems of Food Storage in Northern Nigeria. Bull. Ent. Res. 43 (1) 111-144.

- KHALIFA, A., 1962, The Relative Susceptibility of Some Varieties of Sorghum to Trogoderma Attack. Empire J. Exp. Agric. 30 (118) 133-136.

- KING, H.H., 1921, Rats and Mice. Wellcome Trop. Res. Lab. Ent. Bull. (14).

- KING, S.B., 1970, Covered and Loose Smut of Sorghum in Nigeria. Sorghum Newsletter (13) 65.

  Covered smuth (Sphacelotheca songhi) is estimated to reduce sorghum yields in Nigeria by 5-7% annually. Loose smut (S. cruenta) exceeds 1-2%. Most sorghum seeds in Nigeria carry teliospores of these fungi. One hundred fifty market samples from 40 locations in Northern Nigeria all carried teliospores of S. songhi or S. cruenta or both.

- McFARLANE, J.A., 1968, The Productivity and Rate of Development of Sitophilus oryze (L) (Coleoptera, Curculionidae) in Various Parts of Kenya. J. Stor. Prod. Res. 4 (1) 31-51.

- NYIIRA, Z.M., 1970, Infestation of Cereals and Pulses in the Field by Stored Products Insects and Two New Records of Stored Products Coleoptera in Uganda. East African Agric. For. J. 35 (4) 411-413.

  The study attempts to identify stored products insects infesting growing crops in Uganda. Incubated samples of sorghum, maize, beans, pigeon peas and grams collected from the field revealed one moth and 17 beetles associated with stored products. A further study of mills and stores showed two other beetles, Carcinops quattuordecimstriata and Lyprops badius and an unidentified bruchid, which were regularly found on sorghum in the field.

- OWEN, J.S., 1953, Field Day to the Genera of Sudan Rodents. Min. Agric. Res. Div., Mem. No. 41, and Sudan Notes Rec.(4).

- PARK, P.O., 1974, Granivorous Grain-Eating Bird Pests in Africa --- Toward Integrated Control, Span 17 (3) 126-128.

- PREVETT, P.F., 1963, Stathmopodo auriferella (WLK) (Lepidoptera: Heliodinidae) Infesting Sorghum Stored on the Head in Northern Nigeria. Bull. Ent. Res. 54 (1) 5-8.

- SCUDDER, G.G., 1968, The Identity of Naphius Seed Bug Pests in Africa. Bull. Ent. Res. 58 (2) 205.

- YORK, G.T., 1967, Insect Pests of Cereal Crops in West Africa. Sols Afr. (12) 145-151.

(ii) Environmental

- BRITISH STANDARDS INSTITUTION, 1969, Guidance on Hazards in the Transport and Storage of Packages, Part I: Climatic Hazards, London B.S.I.

- BURRELL, W.J., 1967, Grain Cooling Studies - Effect of Aeration on Infested Grain Bulks. J. Stor. Prod. Res. 3, 145-54.

- DAVEY, P.M. and ELCOATE, S., 1965, Moisture Content/Relative Humidity Equilibria of Tropical Stored Produce. Trop. Stor. Prod. Info. (11) 439.

  Due to differences in methods for determining moisture and relative humidity values for cereals grown in the tropics, relative humidity(moisture content equilibrium values from the literature varied considerably. Methods used by different investigators are outlined. The paper shows relative humidity/moisture content equilibrium values for maize, rice, sorghum and wheat calculated by drawing a mean curve through original results plotted on a graph.

- MACKAY, P.J., 1967, Theory of Moisture in Stored Products. Trop. Stor. Prod. Info. (13) 9-14.

- MAFF, 1973, Spontaneous Heating of Grain in Store. MAFF Advisory Leaflet No. 404.

- OXLEY, T.A., 1945, The Spontaneous Heating of Stored Cereals. J.R. Coll. Sci. 15, 71-80.

- OXLEY, T.A., 1948, The Movement of Heat and Water in Stored Grains. Trans. Am. Ass., Cereal Chem. 6, 84-100.

- PINGALE, S.V. and GIRISH, G.K., 1967, Aeration of Grains. Bull. Grain Tech., India, 5, (3) 161.

- STRONG, R.G. and SBUR, D.E., 1960, Influence of Grain Moisture and Storage Temperature on the Effectiveness of Malathion as a Grain Protectant. J. Econ. Ent. 53 (3) 341-349.

- TSPC, 1972, Safe Moisture Contents for Storage. Trop. Stor. Prod. Info. (23) 10-11.

4. Storage Research and Improvement

(i) General

- ADEYEMI, A.O., 1967, Storage Pests of Cereals (Maize, Millet, Guinea Corn) and their Control in Nigeria. Typed Notes, Res. Div., Min. of Agric. and Nat. Resources, Ibadan, Western Nigeria, 7 pp.

- AGRON. TROP., 1968, Contribution to the Storage of Cow Pea, Maize, Groundnut and Guinea Corn, 23 (9) 982.

- AMARCO, J.P. and CANCELA DA FONSECA, J.P., 1957, Comprehensive Survey of Phytosanitary Problems of Stored Products in Africa. Garcia de Orta, 5 (4) 675-699.

- ANDREWS, 1973, Assessment of Five Small Farmer Grain Storage Projects in Ethiopia and Kenya, FAO.

- ARE, L., 1971, Some Aspects of Food Storage and Transportation in Nigeria. Bull. Rur. Econ. Soc., Ibadan, 6 (1) 95-113.

  The author reports that storage facilities in general are either totally lacking or inadequate, resulting in food crop scarcity during part of the year. Food crop storage problems in Nigeria are discussed and proposals made for reducing storage losses and for ensuring adequate agricultural produce supplies to food processors throughout the year.

- ASHMAN, F., 1965, Some Essential Considerations for Planning Field Trials to Assess the Effectiveness of Insecticidal Treatments Against Stored Products Pests. Trop. Stor. Prod. Info. (11) 425-430.

- ASHMAN, F. et al, 1970, Ashman-Simon Infestation Detector: An Instrument for Detecting Insects Within Food Grains. *Trop. Stor. Prod. Info.* (19) 15-19.

- ASHMAN, F., 1972, Insect Control in Stored Products. Trop. Stor. Prod. Cen., (TPI), 17 pp.

- AUBRAC, R., 1968, War on Waste - The Prevention of Losses in Food and Agriculture. Report by the Interdivisional Working Group, 207 pp.

- BHATNAGAR, A.P., 1971, Considerations for Grain Storages. Bull. Grain Tech. 9 (2) 86-96, New Delhi.

- BONLIEU, A., NICOU, R., & TOURTE, R., 1964, La Conservation des Récoltes au Sénégal Essais sur le Mil, le Sorgho, le Paddy, le Niebe. Agron. Trop. 19 (1) 7-44.

- BOURIQUET, G., 1963, Les Principaux Ennemis et Maladies du Sorgho et Mil en Afrique Tropicale. Agron. Trop. 18 (1) 132-136.

  Most of the paper deals with pests and diseases of growing crops. In the section on stored grains, the main insect pests are listed and insecticides and methods for storage in non-sealed and sealed silos are described.

- CAH. AGRIC. PRAT. PAYS CHAUDS, 1967, Le Séchage et la Conservation sous Climat Tropical., (1) 13-28.

- CAH. AGRIC. PRAT. PAYS CHAUDS, 1971, Storage and Grain Handling, Proc. of: 3, 151-166.

- CALVER, G.L., 1970, Storage and Grain Handling, Proc. of International Conference on Dry Land Farming. John Deere Co., Moline, Ill. pp. 164-191.

- CAMEROUN AGRIC. PAST. FOR., 1969, Le Séchage et la Conservation sous Climat Tropical, (122), pp. 33.

- CASWELL, G.H., undated, Food Storage Problems in Nigeria. Inst. for Agric. Res., Samaru, typed notes, 5 pp.

- CHOYCE, M.A., 1960, Review of Work in Agricultural Entomology - Nigeria. Rep. 7th Comwlth Ent. Conf., pp. 326-327.

  Reviews methods of traditional storage of grain in Northern Nigeria. Lists major insect pests and discusses an effective lindane treatment for stored grain. Describes a four-year experiment with an underground store filled with 130 tons of guinea corn and covered by roofing felt. There was little deterioration in most of the grain but about 1% had been damaged by rain entering the roof. Recommends a concrete roof be put on storage pits.

- COTTERELL, G.S. and HOWE, R.W., 1952, Insect Infestation of Stored Food Products in Nigeria. (Report of a survey, 1948-50, and of control measures adopted), Colonial Res. Publ. No. 12, London: HMSO, 40 pp.

- DELASSUS, M. and POINTEL, J.G., 1970, Résultats des Travaux et des Récherches Réalises par l'IRAT en Afrique sur la Conservation des Stocks de Produits Vivriers. Agron. Trop. 25 (10-11) 945-951.

- EAST AFR. AGRIC. AND FOR. RES. ORG., 1965, Sorghum Pest Control, Ann. Rep. pp. 89-91.

- EASTER, S.S., 1947, (ed.), Preservation of Grains in Storage. Papers presented at the International Meeting on Infestation of Foodstuffs, London, 5-12 Aug. 1947, Wash. D.C.: Fd. Agric. Org., Agric. Stud. No. 2, 1948, 174 pp.

- FAO Bull. de la Commission Réguinale Mixte, 1965, L'Alimentation et la Nutrition en Afrique. FAO/OMS/CCTA No. 3.

  This report discusses the present situation in Africa as regards: cereal storage, food product storage, food industries and food research institutions. Nutrition work being done in Uganda is briefly reviewed and the problem of endemic goiter in Africa discussed.

- FAO, 1965, Some Essential Considerations on the Storage of Food Grains (cereals, legumes and oil seeds) in Tropical Africa. Informal Working Bull. No. 24.

- FAO, Information Div., 1969, Bigger Crops and Better Storage - The role of Storage in World Food Supplies, 53 pp.

- FAO/FFHC, 1970, War on Waste: Grain Storage at Village Level, Tanzania, FH/TAN 11, 7 pp.

- ITA, Senegal, 1970, Conference sur la Conservation, le Traitement et l'Entreposage des Grains. Inst. de Tech. Alimen., Canada + 1, FAO:SF/SEN 5, Rep. No. 58, 87 pp.

- FAO, 1971, A Project Formulation Mission on Farm Grain Storage in Africa. FAO/DEN/TF 51 (DEN), 61 pp.

  The study reports on a mission to Ethiopia, Kenya, Uganda, Malawi, Zambia, Senegal, Ivory Coast, Ghana and Nigeria to assess production, marketing and storage of food grains, observe storage losses and their relationship to climate, determine what research has been done and what facilities exist for storage research. Notes and data on each country

are collected, organised and reported under the following headings: food grains in Africa (production, calorie intake and relation to the growing livestock industry), handling methods (from harvest, local storage, marketing points), losses (types, location and extent) and storage containers in use (traditional and improved methods, what crops, what countries and associated pest control methods). Recommendations are made on what storage and handling methods should be encouraged, pest control, and on the importance of rural storage extension. The storage research and extension programmes now operating in each country are listed and the relationship of storage problems to climatic patterns are assessed.

- FORSYTH, J., 1960, Storage of Sorghum and Millet in Northern Ghana. Rep. 7th Comwlth. Ent. Conf. pp 281-82.

  A list of commonly found insect pests of stored grain in Ghana is presented. The author believes that normal sun drying of grain, plus good granary hygiene by farmers ensures low damage levels for the first six months of storage. Application of 11 ppm gamma BHC dust to guinea corn and late millet heads has no effect for the first six months, but may be economical over periods longer than six months and also when applied to early millet, which has not been dried before storage.

- GANZIM, M., 1973, Rapport sur la Situation Alimentaire et le Problème Céréalier dans la République du Tchad. Mimeo, FAO, Rome.

- GHANA ACADEMY SCIENCES, 1966, Survey of Grain Storage. Ann. Rep. 1965-66, Ibbris 6 (1) 3.

- GILES, P.H., 1962, Northern Nigeria Min. Agric., Ann. Rep. 1961-62, pp. 23-24.

  Trials at 21 sites throughout Nigeria showed that 0.5% lindane dust at 10 ppm is often barely economic for farm level grain storage. Reasons for this fact are discussed. A comparison of storage characteristics of grass vs. mud rumbus with various chemical insecticides and with insect proofing is given. An experiment to determine the level of cross-infestation from stores to fields is discussed as well as trials on hermetic storage in modified traditional stores. A recommendation is made that farmers who plan to store grain longer than six months should apply a sandwich treatment of 10 ppm lindane.

- GILES, P.H., 1966, Control of Insects Infesting Stored Sorghum in Northern Nigeria. Samaru Res. Bull. No. 60, pp 145-58.

  Store hygiene is not enough to prevent infestation in unthreshed sorghum in sealed mud granaries in N. Nigeria. Threshing did reduce populations of Sitotroga cerealella in storage, but Sitophilus oryzae and others developed more quickly. Heating was likely to occur if storage was continued until after the rains. Varietal differences were discovered for resistance to insect pests, but no variety was totally resistant. Storage and fumigant trials showed that mud granaries could economically be fumigated with 0.5% lindane dust to unthreshed sorghum as a sandwich treatment at a rate equivalent to 10 ppm of threshed grain. Control of infestation in grass granaries is less efficient.

- GILMAN, G.A., 1970, Fungal Spoilage of Stored Food in the Tropics and its Possible Effect on Man. Comwlth. Phytopath News, (1) 4 pp.

  Notes that although the incidence of insect infestation is lessened in underground pit storage, grain will still be liable to fungal and bacterial attack.

- GONEN, M. & CALDERON, M., 1968, Changes in the Microfloral Composition of Moist Sorghum stored under Hermetic Conditions. Trop. Sci. 10 (2) 107-114.

- GOULD, J., 1973, Rapport du Coordinateur du Stockage des Grains dans les Départements du Sud-Dahomey, Sept. 1973.

- GREENWOOD, B., 1960, Guinea Corn from Nigeria. Trop. Prod. Inst., Rep. June.

  A sample of guinea corn grain from Nigeria was harvested in 1953 and stored for six years at Samaru in an Argentine Tank. Another sample of grain was harvested in 1959 and was assumed to have the same composition at time of harvest as the first one had had. Analysis of the two samples showed that guinea corn could be stored in Samaru Argentine Tanks without losing B-group vitamins or decreasing in palatibility.

- HALL, D.W., 1954, Report on Food Storage in East Africa, HMSO: London.

- _____, 1955, Problems of Food Storage in Tropical Territories. Ann. Appl. Biol. 42 85-97.

- _____, 1956, Report on Food Storage in East Africa. Colonial Office, London.

- _____, 1963, Report on Stored Food Products. Inter-African Co-ordinator, Commission for Tech. Co-op. in Africa, Science Council for Africa, Oct. 1963, DTC:TSPC, -unpublished.

- _____, 1963, Some Essential Considerations on the Storage of Food Grains in Tropical Africa. Informal Working Bull. No. 24, Agric. Eng. Branch, Land and Water Dev. Div., FAO, 1963.

- _____, 1965, Observations on Storage Problems in the Gambia. Unpub. Report, ODM.

- _____, 1966, Some Essential Considerations on the Storage of Food Grains, (particularly cereals, legumes and oil seeds) in Tropical Africa. Informal Working Bull., Agric. Eng. FAO (24), 176 pp.

  Three introductory chapters give food crop production figures for tropical Africa and losses of food during storage. Further chapters discuss factors affecting food value, deterioration of food grains, moisture and temperature considerations, harvesting and drying methods, fungi and animal problems and storage methods. Storage includes methods, types of stores and silos, insect control, rodent control and economic aspects. Appendices include a summary of relevant legislation.

- HALL, D.W., 1967, Storage and Transportation of Food Commodities. Paper read at the Conference on Advances in Packaging with Plastics, London, 14-16 Nov., reprint from: The Plastics Institute Transactions.

- _____, 1968, Prevention of Waste of Agricultural Produce During Handling, Storage and Transportation. Trop. Stor. Prod. Info. (15) 15-23.

- _____, 1969, Food Storage in the Developing Countries. J. Rur. Soc. Arts, 117 (5156) 562-79.

- HALL, D.W., 1970, Handling and Storage of Food Grains in Tropical and Sub-tropical Areas. FAO, Agric. Dev. Paper No. 90, 350 pp.

  This comprehensive book deals with technical data on handling and storage of food grains, especially cereals, legumes and oil seeds in the tropics and sub-tropics. Information is presented under the following headings: losses of stored food (including sections on seven types of losses); factors affecting food value and deterioration (temperature, moisture, processing and pests); bulk and bag storage buildings, including factors affecting each and construction details; drying methods; storage methods (traditional and modern); methods of insect control (traditional, chemical, physical and costs); rodent control; economic considerations, including discussions on co-operatives, marketing boards and the place of storage in improved marketing systems. Eleven pages of references are appended.

- HILL, R.G., 1963, How to Protect Stored Grain from Insects. Imp. Ethiopian Coll. Agric. Mech. Arts, Exp. Stn. Bull. No. 27.

- HOWE, R.W., 1966, Inspection of Produce and Premises. Trop. Stor. Prod. Info. (12), 475-479.

- IAR, Samaru, 1963, Ann. Rep. 1962-63, ABU, Zaria, Northern Nigeria.

  It was found that short Kaura Sorghum was twice as badly damaged by insects in store as Farafara. Reports on various insecticide trials in earth granaries are discussed. Recommendations for farmer storage and use of lindane dust are given.

- INTERNATIONAL: European and Mediterranean Plant Protection Organisation, 1968, Report of the International Conference on the Protection of Stored Products, Lisbon, 27-30 Nov. 1967, EPPO Publ., Ser. A, No. 46-E, Paris: EPPO, 1968, 171 pp.

- _____, 1969, Report of the Working Party on Stored Products of Tropical Origin. (Hamburg, 5-6 Nov. 1968), EPPO Publ. Ser. A, No. 51-E, Paris: EPPO, 1969, 38 pp.

- IRAT, 1971, Research on Stored Product Protection in the Tropical Areas. FAO, ESR-CAR/71/42, Ibadan, 6 pp.

- _____, 1973, Essai de Conservation, Projet IRAT-U.S. Peace Corps, - also Note Tech. No. DY37-5/6/73 and Note Tech. No. DY21-19/5/72.

- JAMESON, J.C. (Ed.), 1970, Agriculture in Uganda, 2nd Edition, London: Oxford Univ. Press, 395 pp.

  This collection of papers represents a revision of J.D. Tothills first (1940) edition. It provides a fairly comprehensive picture of Ugandan agriculture. Special emphasis is placed on banana, finger millet, cotton and coffee production. Crop storage, implements and mechanisation are also discussed.

- JAMIESON, M.F.S., 1968, The Conditions of Storage for World Food Programme Commodities Supplied to Bolivia, Brazil, Senegal and UAR; a Report of Observations made during Visits to These Countries during the Period 14 Nov. to 15 Dec., 1967. Slough, England, 30 pp.

- KAMEL, A.H. and SHAHBA, B.A., 1958, Protection of Stored Seeds in Egypt. Bull. Min. Agric. Egypt, Ext. Dep., No. 295, Cairo: General Org. for Gov't Printing Offices, 16 pp.

- KELLEY, M.A.R. and BOERNER, E.G., 1930 (revised 1940), Farm Bulk Storage for Small Grains. U.S. Dept. Agric. Fmrs. Bull., No. 1636, 46 pp.

- KENYA, 1969, A Simple Device for Admixing Insecticide Dust with Grain - The Fuffle. Agric. Info. Centre, Min. Agric., Kenya, 4 pp.

- KHALIFA, A.L., 1960, On Open-Air and Underground Grain Storage in the Sudan. Bull. Soc. Ent., Egypt (44) 129-42.

- KOCKUM, S., 1965, A Review of Stored Products Work in Kenya. XI SEIC Meeting, Kampala.

- KRISHNAMURTHY, K., et al, 1967, Studies on Rodents and Their Control. I. Studies on Rat Population and Losses of Food Grains. Bull. Grain Tech. India 5 (3) 147-153.

- LUNAN, M., 1963, Food Position in Tanganyika, in: 1st draft report on the National Seminar for Tanganyika of Food and Nutrition Planning, Dar es Salaam, 26-28 May, 1963, pp. 39-44.

- MARSHALL, G. & MUNRO, J.W., 1940, The Storage of Foodstuffs in the Colonial Empire. East Afr. Agric. J. (5), 446-459.

- McFARLANE, J.A., 1969, Stored Products Insect Control in Kenya. Trop. Stor. Prod. Info. (18) 13-23.

- McFARLANE, J.A., 1969, A Study of Storage Losses and Allied Problems in Ethiopia. TPI, Trop. Stor. Prod. Cen., R40, 67 pp.

  A detailed assessment of the types, extent and significance of storage loss in relation to altitude, farming methods and marketing systems is presented. A 5-6% loss in farm storage appears average but little appears feasible to reduce this in the short run. The losses of 5-10% at the co-operative and marketing end have potential for reduction or for being kept to a minimum in the Grain Corporation and large traders' stores. Recommendations are made for the organisation of an agency(s) to oversee stored produce protection at various levels. The results of a survey and interviews on the condition of grain storage practices in Ethiopia are presented. Comments are made on

rodent, mould and insect damage, moisture loss, underground pit storage, quality control methods being used, metal bin storage assessment, extension programmes on storage and the misuse of pesticides. Recommendations on improvement of all the foregoing areas are made and indications of further research requirements noted.

- McFARLANE, J.A. and WARUI, C., 1973, A Simple Technique for Stored Products Infestation Surveys. Trop. Stor. Prod. Info. (24), 17-24.

- MUNRO, J.W., 1966, Pests of Stored Products. Hutchinson and Co. (publishers) Ltd., London, 226 pp.

  This book is not area specific, but covers the whole subject of stored product insects and their control. The first chapters deal with general entomology and insect ecology followed by more specific studies of insect pests by taxonomic order. Further chapters deal with the general infestation problem and control of infestation, followed by specific means of control; hygienic, physical and chemical. The final chapter deals with the role of legislation in control measures.

- OXLEY, T.A., 1955, Grain Storage in Tropical Climates. World Crops 7 (12) 1-5.

- OYENIRAN, J.O., 1971, A Comparison Between Direct and Dilution Plating Methods of Isolating Moulds from Grains. Nig. Stor. Prod. Res. Inst., Tech. Rep. No. 5, 39-46.

- _____, 1969, Description d'une Méthode de Stockage des Grains à la Ferme par un Procédé de Conservation Hermétique en Utilisant des Bidons Metalliques. Rapport No. 19, Projet FAO (F.S.) SEN 5, Dakar.

- PATTINSON, I., 1970, Grain Storage at Village Level. FFHC Programme Report, TAN/11, FFHC/FAO, Rome.

- _____, ET AL, 1973, Conférences sur les Aspects Techniques et Economiques de l'entreposage des Grains. ITA, Senegal, FAO, AGS/SEN/64/505, 145 pp.

  This report presents a fairly comprehensive review of grain storage with the view of aiding the Gov't of Senegalin setting up a co-ordinated programme of treatment and storage of food grains. The report is divided into 14 chapters, covering such subjects as: the identification of insect pests in food, methods of infestation, physical factors of proper grain storage pesticides, methods of preparing and diluting insecticides, rodent pests and rodenticides and the economics of grain storage. Fourteen appendices embellish the information presented in the main body of the report.

- _____, 1973, Problèmes de Stockage au Sénégal. Rap. No. 109.

- PEACE CORPS/DAHOMEY, 1973, Rapports sur le Stockage des Grains dans les Départements du Sud-Dahomey. July-Sept. 1973, 8 reports.

- PETERS, R., 1963, Report on Grain Storage in the Somali Republic., USOM.

- POINTEL, J.G., 1967, Les Problèmes du Stockage des Grains et Céréales au Sénégal. Rap. Provisoire No. 2, Projet FAO (F.S.) SEN 5, Dakar.

- _____, 1968, Contribution à la Conservation du Niebe, du Voandzou, du Mais, des Arachides et du Sorgho. Agron. Trop. 23 (9) 982-86.

- _____, 1971, La Protection des Stocks au Niveau du Cultivateur Africain. Cah. Agriq. Prat. Pays Chauds, No. 3, 1-16.

- PREVETT, P.F., 1963, Infesting Sorghum Stored on the Head in Northern Nigeria. Bull. Ent. Res. 54 (1) 5-8.

- RAWNSLEY, J., 1968, Biological Studies in Ghana in the Control of Cadra cautella (Wlk.), the Tropical Warehouse Moth. Ghana J. Agric. Sci., 1 (2) 155-159.

- _____, 1969, Crop Storage, Food Res. and Dev. Unit, Ghana, FAO, PL:SF/GHA 7, Tech. Rep. No. 1, 89 pp.

  This report deals with the principles of storage of a wide variety of food crops grown in Ghana. The interrelationships of relative humidity, micro-organisms and moisture content of foodstuffs is discussed, as well as application of insecticides. Common insect pests are listed for the various crops. Annual post-harvest losses in maize and other crops are estimated and detailed data on post-harvest losses in maize from a study of the Ewebana are given. Methods of controlling insect losses in maize are outlined. Experiments into losses occurring in beans are discussed and control measures proposed and tested on a pilot scale. The design of a simple crop dryer is presented. Various other aspects of losses and control in crops other than cereals are described.

- ROSS, A.C., & WULLER, J.H. de, 1963, Recommendations for the Storage of Edible Cereals in Humid Tropical Areas with Special Reference to Southern Sudan. Trop. Stor. Prod. Cen. - separate.

- SHAW, A.F., 1970, Principles in Grain Storage and Handling on the Farm. Proceedings of International Conference on Dry Land Farming, John Deere Co., Moline, Ill. pp. 294-296.

- SHUYLER, H.R., 1970, Control of Rodents and Grain Eating Birds. Rep. to the Gov't of the UAR., FAO, AGP:RP 5/70, 15 pp.

  The publication reports on a survey undertaken to review the rodent problem in field and in storage in the UAR, assess the present organisation of rodent control and make recommendations for its improvement. Five rodent species were identified, the most prevalent being the Black Rat. Losses in field crops and to crops in storage were estimated at 4-5% and appeared to be increasing with time. Maize suffered the second worst losses of all the crops assessed. Some poison baiting was being done. An appendix reviews the grain eating bird problem. Damage from birds occurs at both the pre- and post-harvest stage. Wheat and rice suffered the heaviest losses, maize, third (primarily from pigeons and doves). Total damage levels to crops reached 5-6%. Recommendations are made for improved communication between involved agencies, improved control measures and setting up of rodent control teams.

- _____, 1972, Rodent Control in the Tropics. Paper presented at the 24th International Symposium on Crop Protection, Ghent, Belgium, 9 May, 1972, Mededelingen Fakulteit, Landbouw Wetenschappen, Ghent, 37 pp.

  This is a general paper on the practical, administrative and organisational aspects of rodent control in the tropics. There is no extensive body of knowledge as yet on rodent control in tropical areas. The necessity of organisational structures, extension work and evaluation to any control programme is stressed. Generally, rodent control is attempted on stored products before field crops due to economic considerations. Rodent control methods are briefly reviewed and include: Cultural practices, exclusion, biological control, trapping and poison baiting. All of these control methods are usually integrated into any control project. The importance of making opinion leaders in an area aware of the rodent problem is particularly stressed.

- TAN, K., 1968, Crop Protection in Subsistence Agriculture. PANS, London, 14 (3) 397-402.

  The main question to be considered in introducing pest control measures is how they will interact with the ecological unit (village and environs). Caution is advisable when recommending pest control measures and predicting their results, because of the many unknown factors which may cause unforeseen outcomes. Introduction of innovations in such a way as to minimize consequences of failure may be best even if, by so doing, the optimum impact is not achieved. The economic, cost/benefit ratio, is also important in introducing improved pest control measures. Examples of these ideas are given from experience of treating cow pea and groundnut crops in Africa.

- TANGANYIKA, 1956, Storage Tanganyika. Ann. Rep., Dept. Agric., 1955, Part I, pp 11.

- TROP. STOR. PROD. INFO., 1973, Ibadan Grain Storage Seminar (25).

  This special issue contains abstracts of papers presented at a seminar on Grain Storage in the Humid Tropics, held at Ibadan, Nigeria, 26-30 July, 1971. Included in the papers given are: Drying: - systems available and conditions necessary for successful application, Grieg, D.J.; Aeration of grain: - benefits and limitations, Calderon, M.; Efficiency and economics of locally produced and imported structures, Osobu, A.; Control of storage insects by non-chemical methods, Whitney, W.K.; Microbiological deterioration of foodstuffs during storage in Nigeria, Broadbent, J.A.; Economics of storage and effect on prices, Antonio, Q.B.O. In all, 27 papers are presented in abstract form, including a number of reports on case studies in various countries.

- UGANDA PROTECTORATE, 1962, Storage of Agricultural Produce. Dept. of Agric., 31 pp., Storage of Sorghum, pp 16.

  If stored on the head, sorghum is very susceptible to attack by the moth, Sitotroga cerealella. If the commodity is stored in bulk, the moth can only penetrate the surface 3 inches. The weevil, Sitophilus oryzae breeds well either

in bag or bulk stored grain. Fumigation can be used to control these insects if the sorghum is being stored in bulk. If stored in bags, these should be dusted with malathion or BHC or sprayed with DDT or malathion wettable powder.

- WATT, M.J., 1969, Grain Storage and Marketing in the Somali Republic. Trop. Stor. Prod. Info. (18) 25-32.

- WEST AFR. STOR. PROD. RES. UNIT, 1958, Ann. rep. Dept. Mktg. and Exports, Nigeria, pp 54-65.

  This annual report consists of brief descriptions and reviews of several tests being carried out by the unit, including:
  1) A short review on the grain storage situation in Nigeria.
  2) Famine Reserves - in the northern region.
  3) Underground Pit Storage of Guinea Corn.
  4) Experiments with Native Rumbus - description of the set-up.
  5) Insecticide Treatment of Guinea Corn - description of start of the trial.
  6) Hermetic Storage of Guinea Corn in 44 gal. drums at Mokwa.
  7) Crib Storage of Maize - trials of different levels of BHC dust.
  8) Silo Storage Project at Ibadan - moisture migration.
  9) Pre-cast Concrete Silo - description of silo.
  10) Maize Stored in an Aluminium Silo - germination and damage levels from various parts of the silo.
  11) Hermetic Storage of Cow Peas in 44 gal. drums compared with a control sack.

- WEST AFR. STOR. PROD. RES. UNIT, 1959, Ann. rep., Dept. Mktg. and Exports, Nigeria, pp 29-53.

  This annual report consists of brief descriptions and reviews of several tests being carried out by the unit, including:
  1) Establishment of Famine Reserves in the Northern Region.
  2) Experiments with Native Rumbus - effectiveness of BHC dust on unthreshed guinea corn.
  3) Underground Grain Storage Pit - storage of guinea corn in pits.
  4) Hermetic Storage of Guinea Corn in 44 gal. Drums.
  5) Crib Storage of Maize - effectiveness of BHC insecticide.
  6) Silo Storage Project at Ibadan - storage of maize (report).
  7) Grain Drying: Sept.-Oct. 1958, using an "in-tray" type dryer.
  8) The Cost of Drying and Handling - of maize.
  9) Silo Storage of Dried Maize - comparison between concrete and aluminium bins.

- WEST AFR. STOR. PROD. RES. UNIT, 1961, Ann. rep., Fed. Min. Commerce and Ind., Nigeria, pp 71-102 and 123-139.

  This publication of the annual report includes:
  1) Notes on Grain Storage under Plastic Sheets in Northern Nigeria, (Prevett, P.F.).
  2) An Investigation into Bulk Storage of Sorghum in Five Cylindrical Aluminium Silos (Prevett, P.F.).

3) An Investigation on the Storage of Unthreshed Sorghum in Rhumbus in Northern Nigeria, (Prevett, P.F. and Halliday, D.).
4) Small Scale Storage of Maize in Northern Nigeria (Cornes, M.A. and Riley, J.).
5) A Preliminary Test of Insecticides for Use in Maize Cribs in Western Nigeria, (Riley, J., Cornes, M.A. and Halliday, D.).
6) The Possible Use of Nupe-Type Rumbus for Maize Storage in the Western Region, (Emenike, F.C.O.).
7) Repellency of Pyrethrin/Piperonyl Butoxide Impregnated Kraft Paper in Relation to Phototaxis of Tribolium castaneum (Herbst.), (Cornes, M.A.).
8) Repellency of Crepe Paper Tape Treated with Synergised Pyrethrins to Tribolium castaneum (Herbst.), (Riley, J.).
9) The Persistence of Two DDT Formulations on Concrete Blocks in Northern Nigeria, (Halliday, D. and Prevett, P.F.).

- WEST AFR. STOR. PROD. RES. UNIT, 1962, Ann. rep., Fed. Min. of Commerce and Ind., Nigeria, pp 70-112.

This annual report consists of a number of reports dealing with storage of cereals and cow peas. They include:
1) A Preliminary Test of Sevin for Use in Maize Cribs in the Western Region of Nigeria, (Cornes, M.A.).
2) An Investigation of Drying Rates and Insect Control in a Maize Crib with Improved Ventilation, (Cornes, M.A. and Riley, J.).
3) Underground Pit Storage of Sorghum, (Prevett, P.F.).
4) 8 WASPRU/UCR, Grain Storage Project Reports: 1. Investigations on Maize Storage in two Concrete Block Bins and one Steel Bin, (Caswell, G.H.), 2. Costs of Maize Storage (Upton, M.), 3. Guinea Corn Storage in an Aluminium Silo and a Concrete Stave Bin (Caswell, G.H.), 4. The Cost of Guinea Corn Storage in Silos (Upton, M.), 5. Cowpea Storage in a Concrete Bin (Oputa, C.D.), 6. The Persistence of Sevin on Concrete (Halliday, D.), 7. Toxicity of Paper and Card Surfaces Treated with Lindane and Synergised Pyrethrins (Cornes, M.A.), and 8. Persistence of Insecticide Dusts Used as Insect Barriers (Halliday, D.).

- WORLD FOOD PROGRAMME, Note Circulaire sur la Conservation des Denrees Cordeau. Article on food storage prepared by the WFP advisor to Upper Volta.

(ii) Structures

- ADESUYI, S.A., 1971, A Summary of Research on Drying and Local Storage Structures for Grains. Nig. Stor. Prod. Res. Inst. 5 pp.

- BAILEY, S.W., 1965, Airtight Storage of Grain; Its Effect on Insect Pests. IV. Rhyzopertha dominica (F) and Some Other Coleoptera that Infest Stored Grain. J. Stor. Prod. Res. (1) 25-33.

- BHATNAGAR, A.P., 1966, The Bhatnagar Bin. Extension Pamphlet.

- CAH. AGRIQ. PRAT. PAYS CHAUDS, 1969, Hermetic Silo for the Storage of Cereals. (4) 207-14.

The article describes construction of a modified metallic silo for hermetic storage of cereals at the smallholder level. The silo consists of an iron tube frame set obliquely in a round concrete base, supporting a round, doubly reinforced concrete wall. The silo is capped by a removable aluminium top. The estimated cost in French-speaking African countries is $250 U.S. for a silo capable of holding five tons of paddy rice.

- _____, 1971, Stored Product Protection for African Smallholders., (3) 151-166.

The article describes a simple and practical way of storing cereal grain at the farm level for developing country extension workers. White plastic bags (50 x 110 cm) are filled with clean, dry, insect-free cereal grain and fumigated with a capsule of CCl_4. The bags are then closed, placed on a raised platform supported on poles enclosed by metal cylinders for rodent protection and covered with straw.

- COVENEY, R.D., 1969, Sacks for the Storage of Food Grains. Trop. Stor. Prod. Info. (17) 3-22.

- DAVEY, P.M. & AMOS, T.G., 1961, Testing of Paper and Other Sack Materials for Penetration by Insects Which Infest Stored Products. J. Sci. Fd. Agric., 12 (3) 177-87.

- FAO, 1961, Hermetic Storage of Guinea Corn. Grain Stores Newsletter, Nos. 3 & 4, pp 6.

WASPRU has conducted research on hermetic storage of various grains with encouraging results. One of the latest experiments dealt with hermetic storage of guinea corn in 44 gal. drums. The grain had an initial moisture content of 10% and moderate insect infestation. After 2½ years storage, the moisture content had remained almost constant; no appreciable fall in germination rate was recorded and insect damage showed no increase after self-sterilisation had taken place. No live insects were found after the initial examination.

- FULLERTON, R.L., 1968, Low-Cost Farm Buildings for Storage and Equipment Housing in Ghana. Ghana J. Agric. Sci., Accra, (1) 165-70.

Description and design of a parabolic - arch building for storage of agricultural produce or farm equipment is outlined. Building materials are sun-dried, soil blocks and soil-water-grass mortar. No cement is used, but a bitumen-soil mixture is necessary to provide a waterproof outer shell.

- GONEN, M. & CALDERON, M., 1968, Changes in the Microfloral Composition of Moist Sorghum Stored Under Hermetic Conditions. Trop. Sci. 10 (2) 107-114.

- HALL, D.W. & HYDE, M.B., 1954, The Modern Method of Hermetic Storage. Trop. Agric. 31 (2) 149-169

- HOBBS, W., undated, A Construction Guide for Intermediate Size Grain Storage Structures on Ethiopian Farms. Haile Sellassie University Coll. Agric., Exp. Stn. Bull. No. 24, 28 pp.

  Basic design and construction requirements for grain storage structures are outlined, covering general considerations for floor, wall, roof and opening designs. Detailed plans for two intermediate size storage buildings suitable for grain storage are given; one of a wood frame construction, the other of reinforced concrete block. The costs of both can be paid off within 2-3 years at present wheat prices. Both buildings are for bulk storage primarily, but are not of airtight construction.

- HOBBS, W. & BERHANE BERHE, undated, A Low Cost Family Size Metal Grain Storage Structure. Imp. Ethiopian Coll. Agric. Mech. Arts, Exp. Stn. Bull. No. 29.

- IRAT, 1973, Fiche Technique pour la Construction des Silos Type CARRERAS. Centre National de Récherches Agronomiques, Bambey, Senegal, 22 pp.

- McFARLANE, J.A., 1970, Insect Control by Airtight Storage in Small Containers. Trop. Stor. Prod. Info. (19) 10-14.

  Gourds from Lagenaria cineraria and related Cucurbits are commonly used in the tropics for grain storage. Coating these gourds with linseed oil or varnish improves their effectiveness (provided the neck opening is tightly sealed) by reducing their permeability to oxygen. Total protection from insect damage to stored grain is unlikely by this method, although it is an improvement over untreated gourds which give reasonable but unpredictable results due to naturally varying degrees of oxygen permeability. The author also discusses the effectiveness of other domestic grain storage vessels.

- O'DOWD, E.T., 1970, Hermetic Storage Trials at Samaru. Samaru Agric. Newsletter, 12 (1) 11-14, IAR, Zaria, Nigeria.

- _____, 1971, Hermetic Storage in Nigeria Using Weldmesh Silos lined with Butyl Rubber. Samaru Misc. Paper, No. 30, pp 1-21.

  Field studies on hermetic storage using weldmesh silos lined with butyl rubber showed high permeability to oxygen after 1-5 months. A similar experiment using different butyl rubber liners showed no degradation after one year. It was concluded that the butyl rubber in the first experiment was inferior in quality. The silos proved easy to handle but avoidance of mechanical and biological damage to the silos required considerable supervision. This method of storage proved acceptable for heavily infested cow peas, but did not work for lightly infested sorghum.

- OZBURN, G.W., ET AL, 1960, Hermetic Storage of Guinea Corn. West Afr. Stor. Prod. Res. Unit, Tech. Rep. No. 11, pp 45-47.

- PINNER, S.H., 1966, (ed.), Weathering and Degrading of Plastics. Symp. Proc., Columbine Press, Manchester, 131 pp.

- PRADHAM, S., ET AL, 1965, Pusa Bin for Grain Storage. Indian Fmg., Delhi, 15 (1) 14-16.

- PRADHAN, S. & MOOKHERJEE, P.B., 1969, Pusa Bin for Storage of Grain. Indian Council Agric. Res., Tech. Bull. (Agric.) No. 2, 11 pp.

- PREVETT, P.F., 1962, Underground Pit Storage of Sorghum. WASPRU, Ann. Rep. pp 79-81.

  In mid-June 1958, an underground pit was constructed at Kano, Nigeria, and filled with sorghum. After four years of regular observations it was emptied. The rapid deterioration in viability, especially after 15 months, is discussed. No Tribolium larvae were ever recorded, but low numbers of adults were always discovered. Reasons for this are proposed. Thiamine content of the grain decreased, but the level of fat acidity was better in the pit than in a bag storage trial. The airtightness of the pit was adequate to cause early elimination of the primary pest, Rhyzopertha dominica, but the secondary pest, Tribolium castaneum, was able to survive.

- RANSOM, W.H., 1960, Buildings for the Storage of Crops in Warm Climates. Dept. Sci. Ind. Res., Trop. Building Stud., No. 2, London, HMSO, 52 pp.

- RAWNSLEY, J., 1968, Prevention of Waste with Special Reference to the Role of Agricultural Engineering. FAO-US/Nat. Acad. Sci., in vol. 2, pp 187-191.

- TROP. STOR. PROD. CEN., & PEST INFESTATION LABORATORY (Fumigant Dept.), 1964, Specifications for Fumigation Sheets. Trop. Stor. Prod. Info. (9), 361-363.

- UNITED KINGDOM, 1953, Reports on Plastics in the Tropics, 2. Polythene. Min. of Supply, HMSO, London.

- UNITED KINGDOM, 1961, The Airtight Storage of Grain. Agric. Res. Council, Some Aspects of Agric. Res., No. 3, HMSO, pp 34-38.

- WALLER, J.H.W., undated, The Waller Village Bin. Unpublished report.

- WATTERS, F.L., 1972, Control of Storage Insects by Physical Means. Trop. Stor. Prod. Info. (23) 13-28.

- WRIGHT, F.N. & SOUTHGATE, B.J., 1962, The Potential Use of Plastics for Storage with Particular Reference to Rural Africa. Trop. Sci. 4 (2) 74-81.

  The paper describes the potential uses of plastics for drying and for storage of grain at farm, village trader, and central depot stores and in transporting grains. A plastic sheet fitted with a drawstring has been developed for sun-drying grain on. Its value lies in the fact that it can be closed over the grain like a purse by pulling the drawstring in the event of rain. Principles of hermetic storage are presented and various designs of such stores using plastics are discussed, for storage at village, farm and trader levels. The application of several fumigants and insecticides into plastic containers are also discussed. Using plastic sheets as a gasproof cover for fumigating stored grain at central depots and the possibilities for the use of plastic-lined sacks and flexible or rigid plastic bulk containers for transporting grain are explained. Certain (actual or potential) problems exist with plastics in the areas of oxygen permeability, length of life and plastic "tainting" of grains.

(iii) Protection

- CALDERON, M., 1965, Protection des Grains en Entrepôt. UNDP/TA, Rep. No. 2059.

- CASWELL, G.H., 1970, The Use of Insecticides in Nigeria. Bull. Ent. Soc. Nigeria (2) 111-114.

- CORNES, M.A., ET AL, 1967, An Assessment of the Value of Phosphine and Ethylene Dibromide for the Control of Pests in Grain Stored in Polythene-lined Sacks. Nig. Stor. Prod. Res. Inst., Ann. Rep., Tech. Rep. No. 13, pp 113-121, Lagos: Fed. Min. Infor., Printing Div.

- DAVEY, P.M. & AMOS, T.G., 1960, Storage of Sorghum on the Head, Treated with Lindane at Samaru in Northern Nigeria. Unpublished report, PIL., ARC., 3 pp.

- DYTE, C.E., 1970, Insecticide Resistance in Stored-Product Insects with Special Reference to Tribolium castaneum. Trop. Stor. Prod. Info. (20), 13-18.

- DYTE, C.E. & BLACKMAN, D.G., 1972, Laboratory Evaluation of Organophosphorus Insecticides Against Susceptible and Malathion-resistant Strains of Tribolium castaneum (Herbst.) (Coleoptera, Teuebrionidae). J. Stor. Prod. Res. 8 (2) 103-9.

  Various organophosphorous insecticides were tried on a malathion-resistant strain of Tribolium castaneum, which had a cross-resistance to a number of other non-phosphorous-based insecticides. Cyanophos was found to be the most effective against both susceptible and malathion-resistant strains, and in addition had a moderately low toxicity to mammals.

- FAO, 1970, Report of the FAO Symposium on Resistance of Agricultural Pests to Pesticides held in Rome, 1969, II, 2a pp., K1974-D.

  Subjects covered in this symposium include: the general biological nature of resistance, how resistance develops and what happens to resistant insects in the field, detecting and measuring resistance and selection of alternative control measures. Pest resistance in stored cereals was discussed as well as in rice, cotton and cattle. Resistant strains can develop from: repeated and widespread use of persistent insecticides, existence of natural genetic resistance and the fact that these resistant genes tend to be dominant.

- GILES, P.H., 1964, Lindane Contamination in Stored Sorghum and Millet in Northern Nigeria. Trop. Sci. 6 (3) 113-121.

  In Northern Nigeria, if sorghum or millet is to be stored on the head for over six months, it should be treated with 0.5% lindane dust at 10ppm. The tolerance limit of 2.5 ppm in food from treated grain will not be exceeded at this rate. The insecticide decreases with time due to volatilisation. Upon threshing, cleaning and milling, more insecticide is lost. In Kenya, unsheathed cob maize should be dusted with 0.5% lindane at 8 oz. per 9 cu. ft., giving an equivalent of 12.5 ppm for shelled maize. In Ghana, recommendations are 0.5% lindane at 4 oz. per cwt. of heads or dehusked ears of millet, sorghum or maize; equivalent to

17 ppm of threshed grain. It is recommended that fumigation should only be done on grains to be stored for six months or longer, as less than this becomes uneconomical due to the level of infestation being too low. Farmers are encouraged to treat only unthreshed grain, as threshing removes much of the lindane.

- GUNN, J.W., 1959, Phostoxin, New Tablet Form Grain Fumigant. Pest Control Magazine, July.

- HALLIDAY, D., 1963, The Stability of 0.5 per cent BHC Dust During Storage in Kano. NSPRI, Ann. Rep., Tech. Rep. No. 15, pp 118-120.

- _____, 1963, A Preliminary Investigation of the Possibility of Using Certain Northern Nigerian Minerals as Insecticide Diluents. NSPRI, Ann. Rep., Tech. Rep. No. 16, pp 120-123.

- _____, & QURESHI, A.N., 1965, Preliminary Investigations of the Suitability of a Northern Nigerian Diatomite as a Diluent for BHC Dusts. NSPRI, Ann. Rep., Tech. Rep. No. 18, pp 101-104.

- HESELTINE, H.K., 1963, A Guide to Fumigation with Phospine in the Tropics. Trop. Stor. Prod. Info. (24) 25-36.

- KASHI, K.P., 1972, An Appraisal of Fenitrothion as a Promising Grain Protectant. Int. Pest Control, 14 (1) 20-22.

  Laboratory tests in India showed fenitrothion to be a possible alternative to malathion in the protection of stored cereals against Tribolium castaneum, Sitophilus oryzae and Bruchus chinensis. Fenitrothion seems better than malathion in a number of ways: toxicity to insects, grain penetration and persistence on concrete, high moisture and high temperature grain.

- KASHI, K.P. & BOND, E.J., 1975, The Toxic Action of Phosphine: Role of Carbon Dioxide on the Toxicity of Phosphine to Sitophilus Granarius (L.) and Tribolium Confusum. Duval Grain Storage, J. Stored Prod. Res. 11 (1) 9-15.

- LOCKWOOD, L.M., 1973, Organophosphate Pesticides for Use as Grain Protectants in India: Degradation of their Residues During Milling and Cooking of Cereal Grains. Kansas State Univ., Dept. of Grain Sci. and Ind.

  During storage, samples of rice, wheat and sorghum in India were treated with varying concentrations of malathion, gardona and sumithion insecticides. Bioassay after a two-month period showed that intermediate and high levels of treatment were effective. Insecticide residue levels were determined before and after milling. Milled product samples cooked by traditional Indian methods, which involved boiling or steaming, resulted in complete degradation of all three insecticide residues. It was found that residue breakdown during milling and cooking by local methods was comparable to the breakdown occurring in the cooking and milling processes studied in the U.S. and Europe.

- LINDGREN, D.L., VINCENT, L.E., & STRONG, R.G., 1958, Studies on Hydrogen Phosphide as a Fumigant. J. Econ. Ent. 51, 900.

- McFARLANE, J.A., 1963, Prospects for Pyrethrum with Particular Reference to Its use in the Control of Pests of Stored Foodstuffs. Trop. Stor. Prod. Info. (6) 202-212.

- MOSTAFA, S.A.S., ET AL, 1972, Toxicity of Carbon Bisulphide and Methyl Bromide to the Eggs of Four Stored Product Insects. J. Stor. Prod. Res. 8 (3), 193-98.

  Eggs of Phestia kuhniella, Sitotroga cerealella, Tribolium castaneum and Sitophilus oryzae at different stages of development were treated with carbon bisulphide and methyl bromide at 26°C and 65% relative humidity. Results show methyl bromide to be much the more toxic of the two. The older the eggs the more susceptible to both fumigants they became. The Lepidoptera were more susceptible than the Coleoptera and S. oryzae was the most resistant.

- NIGERIA, 1958, Ann. Rep., Min. Agric., Northern Nigeria, 1957-/58.

  Discusses fumigation trials on threshed and unthreshed guinea corn stored in rhumbus using 0.5% gamma BHC dust. After 9 months storage, the gamma BHC concentration, even in rhumbus with the highest dosage, were 1.4 ppm or below, the maximum allowable for food being 2.5 ppm.

- PESTICIDES INDIA, 1971, International Symposium on Sorghum, held at Hyderabad, India in Oct. 1971, Vol. 12, pp 35-36.

  Contains information on pests and on utilisation of sorghum.

- PEST INFESTATION CONTROL LABORATORY, TOLWORTH, 1970, Methyl Bromide Dosage Schedules. Trop. Stor. Prod. Info. (20) 27-30.

- SAMARU RES. BULL. 1967, Lindane Contamination in Stored Sorghum and Millet in Northern Nigeria.

- SITHANANTHAM, S., ET AL, 1972, Evaluation of "Minifume" as a Fumigant for Storage Pests. Madras Agric. J. 59 (9-10) 559-60.

  In India, Minifume (ethylene dibromide in tablet form) was placed on the top of sorghum grain in containers infested with Sitophilus oryzae, Tribolium castaneum and Rhizopertha dominica at a concentration of one tablet per 100 kg of grain. The fumigant has a poor diffusibility and was only effective within the top half. Placing ½ tablet on top and another ½ tablet half way down the container proved as effective as two tablets on the top only. This method gave complete control of the infesting insects.

- WEAVING, A.J.S., 1975, Grain Protectants for Use Under Tribal Storage Conditions in Rhodesia. I. Comparative Toxicities of Some Insecticides on Maize and Sorghum. J. Stored Prod. Res. 11 (2) 65-70.

5. Storage Economics

- ANTHONIO, Q.B.O., 1963, Economic Problems of Peasant Storage. Min. Econ. Planning, Econ. Div., Ibadan, Nigeria, pp 58-59.

- MARTIN, A., 1963, The Marketing of Minor Crops in Uganda, DTC Overseas Res. Pub. No. 1, London: HMSO, 78 pp.

  Sorghum is usually stored on the head, but should be thoroughly dried before storing. At least in wet areas, it stores badly, being liable to attack by the granary weevil. Perhaps for this reason, it is one of the crops commonly sold to traders soon after harvest, and later bought back by the original seller at a much higher price. Finger millet is Uganda's most important crop. It is very worthwhile storing for a profit of 50% is often obtainable by selling after four or five months. Its storage qualities are excellent, it will keep for four years on the head and for at least one when threshed, probably more if dried properly.

D. Transport

- BANQUE CENTRALE ETATS AFRIQUE DU L'OUEST, 1962, Data on the Economic Situation of Upper Volta., Paris, 32 pp.

  Gives general information on the nature, men, agriculture and livestock of the Republic of Upper Volta and discusses problems of transportation, communication and immigration.

- ECONOMIST INTELLIGENCE UNIT, LTD. & FREEMAN, FOX, WILBUR SMITH & ASSOC., 1969, East Africa Transport Study, London.

- EDINBURGH: CENTRE AFRICAN STUDIES, 1970, Transport in Africa. Univ. of Edinburgh, 131 pp.

  A Seminar devoted to the problems of transportation in African countries.

- EXPERIENCE INCORPORATED AND KING & GARARIS CONSULTING ENGINEERS, INC., 1970, Lake Chad Basin Transport Survey.

  The study examines three proposed road links in the Chad Basin Administrative District, which includes the regions of Niger, Nigeria, Chad and the Cameroons bordering on Lake Chad. It was felt that such a network could lower the cost of inputs, production and transport of agricultural commodities and end products. The study includes a survey of the existing situation with respect to natural and human resources, transport network and primary and secondary zones of influence along this network. It reviews present and planned agricultural and industrial activity for the area. The study also includes preliminary engineering data, time schedules, costs of construction and maintenance estimates, the economics of bridges versus existing ferry services, organisation of highway maintenance and rates of return both internally and in relation to the costs.

- GUSTEN, R., 1968, Studies in the Staple Food Economy of Western Nigeria. NISER.

  Describes the methodology of transport and produce censuses.

- HAWKINS, E.K., 1962, Roads and Road Transport in an Underdeveloped Country. A Case Study of Uganda. HMSO London, 254 pp.

  This study presents a survey of the present pattern of movement of goods and passengers by road and its cost, an assessment of the capacity, structure and economics of the road transport industry, estimations of its probable expansion and a forecast of the effects of the improved communication on the development of the areas served by the expanded road network. Chapter I gives the background to road transport in Uganda; Ch. III, the traffic patterns and levels; Ch. IV, a description of the organisation of the road transport industry; Ch. V, the cost of road transport; Ch. VIII, Road/rail competition and the controls on road transport, economics, history of road development, taxation and recommendations for future transport policy.

- HAY, A.M., 1968, Geography of Road Transport in Nigeria. PhD Thesis, Cambridge.

- HOFMEIER, R., Trunk Road Transport and the Possibility of a National Transport Policy in Tanzania. ERB Paper No. 68.24.

- INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT, 1969, The Transport Sector in Chad, Wash. D.C.

- MARCH, G.F., 1948, Transport in the Sudan. In: Tothill, Agriculture in the Sudan, Oxford Univ. Press, pp 176-86.

- McMASTER, D.N., 1970, Road Communication and the Pattern of Rural Settlement. In: Transport in Africa, Edinburgh; Centre African Studies, Univ. of Edinburgh, pp 1-21.

- MOORE, A. ET AL, 1972, The Transportation, Processing and Storage of Ethiopian Grains and Pulses for Domestic and Export Markets. Rep. No. IV, Experience Inc., Minneapolis, 41 pp.

  The first part of the report deals with transport. Trucks and rail transport are available, but only to about 20% of the population. Donkey, horse and camel transport are common, but relatively expensive. Numbers of vehicles and extent of road and rail are presented. Competition between truckers and between trucks and one of the two railways is considerable. The other railway, in the north, has control over the operation of truckers. Transport costs have been declining due to better roads and stiffer competition. The relationship of rates to costs of various types of transport are given. The second part of the report on processing and storage deals strictly with proposals. In particular, small and large farm steel bin storage units are suggested and described, in-store drying using fans, and special equipment for handling pulses are recommended. Design of rural market storage and processing centres to serve as agriculture supply centres are outlined.

- MOSES, L., The East African Transport Study: A Preliminary Appraisal. ERB Paper No. 68.6.

- NIGERIA, 1964, Transport. A Guide to Current Costs in Nigeria. Fed. Min. Comm. and Ind., Lagos.

- STANFORD RES. INST., 1961, The Economic Co-ordination of Transport Development in Nigeria.

- TANZANIA, A Guide to Basic Data on Road Transport in Tanzania, BRALUP Notes No. 5f.

- TANZANIA, Transport Planning in Tanzania: An Assessment. BRALUP, Res. Paper No. 8.

- TANZANIA, Trunk Road Transport and the Possibility of a National Transport Company in Tanzania. ERB, Paper No. 68.3.

- TANZANIA, A Note on a Traffic Census Taken on the Mombo-Lushoto Rd. BRALUP, Res. Rpt. No. 25

- UNITED RESEARCH INC., 1968, Economic Feasibility of Improving Two Roads in the Mtwara Region of Tanzania, Dar Es Salaam: Min. Comm., Labour and Works.

- WALKER, G., 1959, Traffic and Transport in Nigeria, London.

E. Large Scale and Off-Farm Storage

1. Research and Improvement

(i) General

- ATTIA, R., 1948, Typical Methods of Handling and Storing Grain in Egypt. In: Preservation of Grains in Storage. FAO Agric. Stud. No. 2, pp 105-109.

- BETHKE, S., 1963, The Usefulness and Feasibility of a Buffer-stock Project for Grain in the Somalia Republic. Report to World Food Programme by Mkt. Econ. ECA/FAO Joint Agree. Div., Addis Ababa.

- CASWELL, G.H., 1962, Grain Storage Project 2, Guinea Corn Storage in an Aluminium Bin and a Concrete Stave Bin. WASPRU Ann. Rep., pp 86-89.

  Guinea corn was stored in both an aluminium and a concrete stave bin. Two months later they were sampled for insects and fumigated with five litres of a 1:1 mix of ethylene dichloride and carbon tetrachloride. They were refumigated after four months and emptied nine months after filling. Insect damage was found to be worst at the top of the bins and especially in the aluminium one. Mean monthly figures for the grain moisture contents are given. It was found that the temperature above the grain in the stave bin was higher than in the other bin and a proposal is made to investigate the effect of this on keeping quality. No undue deterioration of quality or moisture content occurred.

- DEUSE, J. & POINTEL, J.G., Bilan des récherches sur la Conservation des Stocks de Produits Vivriers en Milieu Rural en Afrique Francophone. IRAT.

- DEUSE, J.P.L., 1970, Rapport Préliminaire sur les Conditions de Stockage et de Traitements des Céréales Déterues par le Fond de Developpement et d'Action Rurale. Mimeo., FAO, Dakar, Senegal.

- FAO, 1973, Project Data Summary, Sahel Task Force Short-Term Recovery Activity. DDA:MISC/73/11.

  Various project proposals, their cost, contributing agencies, organisation, duration and resource inputs are summarized for the Short-Term Recovery Project for the Sahel Region. Countries covered are: Niger, Senegal, Upper Volta, Mali, Mauritania and Chad. The projects proposed for each country generally include a storage and a road repair element.

- FURIA, R. di, ET AL, 1970, Rapport sur les Conditions et les Possibilités de Créer dans le Territoire de la République Islamique de Mauritanie un Stock Régulateur et un Stock de Réserve de Mil., W.F.P., Sen. 205/No. 79, 14 pp.

  Reviews the food grain situation in Mauritania and makes recommendations on establishing reserve stocks.

- HALL, D.W., 1965, The Handling and Storage of World Food Programme Commodities in Recipient Countries. Trop. Stor. Prod. Cent., 93 pp.

  This two month survey reports on the problems of deterioration of commodities in recipient countries of WFP deliveries from donor countries. Flour and grain inspected in Africa showed heavy infestation with insects in most cases. Examination of a hammer mill in Tanzania, producing flour from the sorghum and maize grain, showed that infestation was partially originating in the bagging-off chute. Details of insects found, and of moisture and temperature data of the stored grain are given. An evaluation of various types of packaging materials for flour and grain is presented from observations in various donor countries. Storage facilities in Dahomey, Senegal, Sudan and Tanzania are given a brief assessment as are the transportation and distribution procedures and the extent of knowledge and availability of local staff in storage and distribution methods.

- HALLIDAY, D., 1966, Insect Damage to Foods on Sale in a Kano Market. NSPRI, Ann. Rep. Tech. Rep. No. 13, pp 103-107.

  Samples of white and yellow guinea corn, maize and brown and white cow peas were collected weekly from two retailers in Kano for a period of ten months. The samples were tested for moisture content and for species and numbers of live and dead insects present. Results show the main insect pest of guinea corn to be Rhyzopertha dominica (F), of maize, to be Sitophilus sp. and of cow peas, Callosobruchus maculatus (F) and Bruchidius atrolineatus. Damage to guinea corn was always low due to low moisture content, being greatest during Aug.-Sept. Maize damage was greatest during May and although higher than guinea corn, was still low.

No difference in susceptability to insects was noted between white and yellow guinea corn, but brown cow peas appeared slightly more susceptible than white. Cow pea damage was found to be high, increasing steadily until April and then levelling out.

- HOBBS, W. & MILLER, L.F., undated, A Proposed Grain Storage Programme for Ethiopia. Imp. Ethiopian Coll. Agric. Mech. Arts.

- JEPSON, W.F., 1964, Economic Aspects of Entomology. Pest Abst. and News Summ. A. 10 (3), 371-91, (pp 386).

  BHC dust treatment is being used for maize cob protection in cribs in East Africa and Ghana. The bulk storage of maize and sorghum in underground pits or silos has been introduced in the Sudan, Tanganyika and in many areas where the initial moisture content can be reduced below 13.5%. Incipient insect infestation is eliminated by the depletion of intergranular oxygen to under 10%. For larger bulks of infested grain, modern techniques of fumigation with methyl bromide are spreading rapidly from both ends of Africa into the centre, where gov't trained teams undertake this operation.

- KANSAS STATE UNIV., 1970, A Study and Plan for Regional Grain Stabilisation in West Africa. Food and Feed Grain Inst., Manhattan, Kansas.

- KASSEBAUM, J.C. & ABBOT, J.C., 1962, Some Economic Aspects of Grain Storage in Africa. CCTA/FAO Symposium on the Storage of Food Crops, Freetown, Sierra Leone.

  The paper deals with elimination of storage losses, types and sizes of storage facilities, location of these facilities and storage in relation to marketing.

- MORLEY, G.E., 1973, Informal Technical Report on Grain Marketing and Storage, Somalia, Central Grain Storage. UNDP/SF, FAO, AGS:SOM/507, 15 pp.

- NIGERIA, 1964, Regional Grain Reserve. Ann. Rep., Min. Agric., Northern Nigeria, 1963-64, pp 20.

  Some of the guinea corn has now been in stock for nearly four years and remains in excellent condition, although palatability will suffer if it is not disposed of and replaced with new stocks soon.

- PATTINSON, I., 1968, Report to the Gov't of Tanzania on Crop Storage Problems. FAO No. AT2454 - PL:TA/69.

  The report covers such areas as drying of crops (by crop), a review of the present organisation and workings of the crop inspection staff, which includes storage extension services. Present legislation covering storage is presented as well as a discussion of the recent developments in the storage field, including such things as: bulk storage, insecticidal treatment, drying and initiation of a pest control unit. The final section gives concise recommendations on crop storage, training, pest control and legislation requirements.

- RANNFELT, C., ET AL, 1967, Survey on Storage and Handling of Food Grains and Other Crops in Tanzania. Agriconsult Rep. to the Min. Agric., Tanzania.

- RICCI, C., 1964, Report to the Gov't of Somali on Grain Silos. EPTA Rep., FAO No. 1905, 27 pp.

  Grain production and consumption are briefly reviewed. The uncontrolled grain market system is described and its effects on farmer production assessed. Market price figures for months of 1963 and 1964 are tabulated and recommendations made for improving the grain marketing situation. The grain storage facilities currently available are assessed individually and recommendations made for renovation of, and additions to, storage facilities, improved transport equipment for use during the rainy season, training of personnel in storage techniques and instigation of grain standards and quality control. Cost estimates for storage facility (silo) construction and renovation are presented in the appendices.

- TROP. STOR. PROD. CEN., 1970, Food Storage Manual, prepared by TSPC for the World Food Programme., 799 pp.

  The manual is a comprehensive study on the problems of food wastage in storage, with particular relevance to developing countries. It is presented in three parts. Part I deals with storage theory, including: chemical, physical and biological aspects, storage insects, microbiological and rodent pests and their biology and the relationship of temperature and moisture content to storage deterioration. Part II deals with technological aspects of commodities, including: packaging, handling, storing, methods of manufacture and packing and their relationship to deterioration of foodstuffs. Part III covers types of storage buildings, warehouse management, produce inspection and methods of pest control.

- WATT, M.J., 1971, Grain Storage and Crop Protection: Grain Marketing, Storage and Price Stabilisation, Somalia. FAO, ESP:SF/SOM 7, 47 pp.

  The report covers most crops grown in Somalia and makes continual reference to previous work on storage and crop protection done under the same project. Harvesting, threshing, drying and underground farm pit storage of grain crops are described and recommendations for improvement (primarily better drying), are made. Commercial storage and commonly found insect pests are briefly discussed. Various gov't marketing and storage organisations have been operational in the past, but at this time are not. Suggestions are made for improved pest control programmes, research, laboratories and alternative storage methods. The remainder of the report is concerned with other than grain crops. A summary of recommendations on farm, commercial and crop storage is given. It is considered that attempts at new forms of farm storage should not be made at present.

- WOODWARD, W.B., 1959, Notes on Nigerian Visit.

  Detailed descriptions are given on local harvesting and storage techniques, including: capacities, moisture contents of grain sorghum and lists of common insect pests. A regional food reserve programme at Nassarawa is discussed, giving details of fumigation with methyl bromide under plastic sheets and cautioning against possible adverse moisture migration.

- WRIGHT, F.N., 1965, New Storage, Transportation and Handling Techniques for Tropical Agricultural Produce. C.R. Trav. Congr. Prat. Cult. Trop., Chambre de Commerce et d'Industrie de Marseille. pp 93-98.

(ii) Structures

- BOON LONG, S., SMITH, R.B.L. & LOO, Y.C., 1969, Hermetic Silo for the Storage of Cereals., Cah. Agric. Prat. Pays Chauds, (4) Tech. No. 75, pp 207-214.

- CAH. AGRIC. PRAT. PAYS CHAUDS, 1968, Silo Etanche pour le Stockage des Grains en Vrac., (2) 43-52.

- CROSS, D.E., 1959, The Construction of Grain Storage Facilities in Ethiopia and Eritrea. Unpublished Report to Ethiopian Min. Agric. and U.S. Operation Mission to Ethiopia., Addis Ababa.

- FORREST, R.S., 1968, Grain Storage (Informal Report), UNDP/SF, Grain Marketing, Storage and Price Stabilisation Project, FAO, LA:SF 68/52, 13 pp.

- HALL, D.W., HASWELL, G.A. & OXLEY, T.A., 1956, Underground Storage of Grain. Colonial Res. Stud., No. 21, 27 pp.

- HENDRIKSON, K.H., 1966, Feasibility Study on the Renovation and Enlargement of Grain Storage Facilities in Somalia, 57 pp.

- HOBBS, W. & ZAWDU FELLEKE, 1965, The Design and Construction of a Twenty-Ton Capacity Corrugated Metal Grain Storage Bin. Imp. Ethiopian Coll. Agric. Mech. Arts., Exp. Stn. Bull. No. 32.

- HOLMAN, L.E., 1969, Improving the Handling of Grain in Indian Wholesale Markets, Proposals for Testing Bulk Handling in Mamdis. Rep. of the Ford Foundation, New Delhi.

  The paper discusses assembly and storage facilities for larger wholesale markets and assembly facilities for small wholesale markets, as well as portable machinery for cleaning, bagging and weighing in market yards. A recommendation is made that one or more test facilities be erected to study bulk handling. Specific information for constructing such facilities are given.

- HYDE, M.B., ET AL, 1960, Underground Storage of Grain. Pest Infest. Res. 19 pp.

- JENNINGS, M.W. & DOBROUSKY, T.M., 1957, The Construction of Grain Storage Facilities at Alexandria and Cairo. UNDP/TA, Rep. No. 761.

- LOPEZ, C.O., 1971, Rapport sur la Possibilité de Construire des Silos Souterrains Hermétiques en République Islamique de Mauritanie. Rapport de Consultant su PNUD auprês du Gouvernement de la Mauritanie.

- PATTINSON, I., 1972, Le Stockage de Cereales de Reserve en Entrepots Etanches, ITA, Senegal, FAO, AGS:SF/SEN 5, Tech. Rep. No. 9, 39 pp.

  This report deals with the principles and practices of bulk storage of grain in airtight containers. A discussion of the benefits of reserve stocks of grain is presented,

followed by an explanation of the principles of airtight grain storage. Chapters 4 and 5 review the situation with regard to the Cyprus Bins in Kenya and the underground silos being used in Argentina. The last chapter discusses the possibilities of erecting Cyprus Bins in Senegal for a reserve stock programme. Appendices give construction details of Cyprus Bins and the underground silos.

- RANSOM, W.H., 1961, Storage of Crops in the Tropics. The Design and Construction of Stores. World Crops, 13 (11) 425-428.

- SAKHO, C.Y., 1971, Rapport sur l'operation "Canagrenier" de Conservation des Grains par Fûts Hermétiques. Republic of Senegal, Inst. Tech. Alimen. 24 pp.

(iii) Protection

- CAMEROUN AGRIC. PAST. FOR., 1968, Making Grain Stores Insect Free for Co-operatives and Commercial Warehouses. (119) pp 14.

  The article is a summary of a broader pamphlet by M.A.L. Lepigre on preventing and curing insect infestation on larger than farm-level grain stores. It includes recommended doses for lindane, malathion, pyrethrum and DDT.

- CORNES, M.A., 1965, An Assessment of the Efficacy of Phostoxin for Control of Grain Pests in Silos. NSPRI, Ann. Rep., Tech. Rep. No. 16, pp 91-93.

  A description is given of a fumigation trial on 15 tons of heavily infested sorghum, stored in a steel silo, using three tablets of phostoxin per ton of grain. The tablets were dispersed at the three foot level and left under a polythene seal for four days. The fumigation proved only to be of moderate success, especially in the middle and bottom of the silo. Plans are mentioned for trials of higher dosages in the future.

- HALLIDAY, D., 1966, Field Studies of Fumigation of Produce from Northern Nigeria with Phosphine. NSPRI, Ann. Rep., Tech. Rep. No. 4, pp 35-59.

  Phostoxin fumigation trials on stored guinea corn, milled rice and groundnuts are described in detail. The guinea corn stacks belonged to the Northern Region Grain Reserve near Kano and consisted of bagged grain stacked on sisal-kraft paper dunnage, laid on concrete floors within an Arcon Store or conventional cement block, iron-roof store. Measurements were made of temperatures in the grain stack and ambient temperature, moisture content of the grain and the fumigant concentration over time. Results showed that a dosage of two tablets/ton was sufficient for complete insect control. In the dry northern regions, fumigation should last 5-7 days. Fumigant residues were fairly high, i.e., between 6.1 and 9.5%.

- IPSAC, 1962, A Memorandum for Phytosanitary Procedure in Africa, Inter-African Phytosanitary Commission Publication No. 82.

- LE CONTE, J., 1966, The Effects of Treatment of Sorghum by Gametocide FW 450 in a Station, North Dahomey, 1962-63. Sols Afr., 11 (1-2) 73.

- McFARLANE, J.A., 1968, The Value of Permanent Monitoring Surveys in the Application of Stored Products Pest Control. 13th Int. Congr. Ent., (Moscow).

- OKWELOGU, T.N., 1969, Produce Inspection in Tropical Africa, World Crops, Sept/Oct.

2. Economics of Storage

- DIOP, I.D., 1971, Rapport sur l'économie du Stockage des Grains, Inst. de Tech. Alimen., Dakar, 1971.

- FAO, 1965, Food and Nutrition in Africa. The News Bulletin, FAO/WHO/CCTA Regional Food and Nutrition Commission for Africa, Nov., No. 3, pp 17-22.

  Reviews some aspects of grain storage in Africa including: factors in costing, determining costing, location of storage facilities, types of storage plants, ownership of the plants and of the stored produce.

- LIPTON, M., 1971, Research into the Economics of Food Storage in Less Developed Countries. Inst. of Dev. Stud., Univ. of Sussex, Communications Series No. 61, 15 pp.

- MARCOMER, undated, Bilan de la Compagne Nationale pour la Protection des Semences et des Récoltes en Haute Volta, FAO.

- STIRLING, H.G., 1971, A Comparison of Storage Costs for Structures of Different Materials. Trop. Stor. Prod. Info. (22) 31-33.

- UPTON, M., 1962, Grain Storage Project 4, The Cost of Guinea Corn Storage in Silos. WASPRU, Ann. Rep., pp 89-90.

  Costing is given for the depreciation of storage bins, for cleaning bins and treating them with BHC dust, and fumigation costs. The market prices of guinea corn show smaller seasonal variation than those of several other crops, therefore, the profitability of its storage will not be as great.

F. Marketing

1. Traditional

- ADEYOKUNNU, T., 1970, The Markets for Foodstuffs in Western Nigeria. O.D.U. News Service, Inst. Afr. Stud., Univ. of Ife, Ile-Ife, No. 3, 15 pp.

  The study had three objectives: 1) to examine the location frequency and time of operations of foodstuff markets, their physical structure, the role of women and of trade associations and the function of the markets; 2) to identify and describe the role of the various middlemen, and 3), to describe the pricing system. The author concludes that improvement is necessary in market information and that the scale and mode of operations must be considerably modified.

- AFRICAN URBAN NOTES, 1970, African Studies Centre, Michigan State Univ., East Lansing, Mich., Vol. 5 (2), pp 3-37, 58-63 and 86-128.

  This volume contains the following articles:
  1) Miracle, M.P., Marketing Bibliography for Africa.
  2) Smith, R.H.T., Notes on Periodic Markets in West AFrica.
  3) McNulty, M.L., African Urban Centres and Markets.
  4) Anthonio, Q.B.O., Distributors in Foodstuff Markets in Nigeria.
  5) Ilori, C.O., Price Formation and Profit Margins in Food Markets of Northern Nigeria.

- AMES, D.W., 1962, The Rural Walof of the Gambia, Markets in Africa, pp 29-60.

- ANSCHEL, K.R., 1970, Agricultural Marketing in Nigeria and Ghana, Dev. Digest, 8 (4) 88-94.

- ANTHONIO, Q.B.O., 1969, Marketing of Staple Foodstuffs in Nigeria: - Study of Pricing Efficiency. PhD Thesis, Univ. of London, 1968-69.

- AYLWARD, F., 1970, The Food-Agriculture Complex in Developing Countries. World Crops, Mar.-Apr. and May-June.

- BAKER, R.W., 1965, Marketing in Nigeria. J. Marketing 29 (3) 40-48.

- BIRDSALL, S.S., 1969, The Spatial Context for Research on Rural African Market Patterns. Can. J. AFr. Stud. 3 (1) 291-96.

  The paper identifies some of the major characteristics of African rural markets, such as: 1) centres of economic, social, political and cultural interaction and change; 2) often the only point of contact between the national economic structure and the individual; 3) essential in the communication network of countries. Problems relating to these characteristics are discussed in their spatial context. Relevant research on market processes and rural circulation are reviewed. Comments are made on the growth of cash crops, which the author feels, support most market activities.

- BOHANNAN, P. & DALTON, G. (ed), 1962, Markets in Africa. Northwestern Univ. Press, 762 pp.

  This publication contains a collection of papers providing a fairly comprehensive coverage of marketing in AFrica. The book is divided into sections, each dealing with a specific area of the continent, including: the Western Sudan, the Horn of Africa, East Africa and a final section on markets in Kampala and Ghana. Each section contains a number of studies which effectively cover the economic and operational aspects, the non-economic, sociological functions of markets and the effect of modernisation on traditional African markets through case studies.

- COUNTY, P., 1965, Notes sur la Production et le Commerce du Mil dans le Departement du Diamare. Cah. Orstom Sci. Humaines, 11 (4).

- DAVIS-QUAKYI, J., 1971, Food Storage and Marketing in Developing Countries. Int. Experts Meeting on the Role of the Entrepreneur in Agric. Mkt. Dev., Berlin, 8-13 Nov., 10 pp.

- DE YOUNG, M., 1967, The Internal Marketing of Agricultural Produce and its Influence on Agricultural Productivity and Income. Ethiopian Observer, Addis Ababa, 11 (1) 16-35.

- EBBA, F. & PHILLIPS, R., 1972, Supply and Demand Projections for Food Grains in Ethiopia, 1970-1980. Kansas State Univ., AID/csd - 1588.

  The study deals with supply and demand projections of the major food crops of Ethiopia, including sorghum, maize, teff and pulses, based on the figures for 1961-70. Production increases will occur through expansion of total area rather than in yields/acre and will be highest for sorghum and oilseeds. Improvements will have to be made in the transfer of produce from rural to urban areas and between provinces to offset the enormous urban population growth and income increases. Estimates show that serious shortages of most cereals and pulses will have occurred by 1980. The shortages (or surpluses) of each crop, for each province are projected. Unless grain import policy and production patterns change, a "demand pull price inflation" will threaten the economy by 1980.

- ECHARD, N., 1964, Socio-economic Study of the Valleys of the Ader-Doutchi Majya (Nigeria). Paris: IFAN, CNRS.

  Includes discussions and data on the rural economy, rural sociology, land, agriculture and labour of Nigeria.

- EIGHMY, T.H., 1972, Rural Periodic Markets and the Extension of an Urban System: a Western Nigerian Example. Econ. Geo. 48 (3) 299-315, Worcester, Mass.

  The article analyses Western Nigerian periodic markets in terms of modern economic theory. Supply and demand forces are linked together in the periodic market place and thus, three economic functions are performed simultaneously: internal trade, local exchange and central place functions. Market periodicity, spatial distribution of markets and the role of transport in the system are discussed. Examination of a simulated empirical model of a rural periodic market shows that four distinct elements are involved: market functions, spatial arrangement of periodic markets, movement of traders between markets and response to external forces resulting in expansion to new sites and other modifications. The future of these markets is also discussed.

- ETHIOPIA, 1973, Findings of a Market Structure Survey and Analysis of Those Grains that Provide the Basic Subsistence for the People of Ethiopia. Imp. Ethiopian Gov't, Min. Agric. Planning and Programming Dept., Econ. Res. Div., 211 pp.

  This study represents a comprehensive survey of the present marketing system for wheat, teff, barley, sorghum and pulses in thirteen provinces of Ethiopia. An attempt has been made to analyze the agricultural marketing system, identify the restrictive or inhibitive problems within the system and evaluate the market structural problems. Three different schedules were used to collect information from local traders, traditional farmers and on local storage, grain trade and agroindustry volumes and capacities. From the traders, information was obtained on volume of

trade, origin and destination of grain flows, margins, credit grading practices, etc. Farmers supplied information on such things as credit, prices and incomes, transport to markets, on-farm storage, etc. The appendix gives information on individual large storage facilities, Ethiopian Grain Corporation, transport costs, prices, etc. Recommendations on policy and programme priorities are made.

- FAGERLAND, V.G. & SMITH, R.H.T., 1970, A Preliminary Map of Market Periodicities in Ghana. J. Dev. Areas, 4 (3) 333-48.

Traditional periodic markets are located on a map of Ghana along with their corresponding market week lengths. The idea that markets located near each other will have differing periodicity is discussed as well as other theories. Some results of a 1969 market survey are included at the end of the article.

- FAO/ICA, 1960, Agricultural Survey of Northern Nigeria, Kaduna.

- FAO, 1964, Marketing of Staple Food Crops in Africa, Nairobi conference, 4-29 Aug.

- FENN, M.G., undated, The Role of the Entrepeneur in Agricultural Market Development, FAO.

- FOOD RES. INST. STUD. AGRIC. ECON., 1970, Measuring the Effectiveness of Agricultural Marketing in Contributing to Economic Development: some African Examples. Traditional Development 9 (3) 175-96.

- GILBERT, E.H., 1969, Marketing of Staple Foods in No-thern Nigeria: a Study of Staple Food Marketing Systems Serving Kano City. Diss., Stanford Univ., 365 pp.

This study examines the marketing systems supplying Kano City with millet, sorghum, cow peas and rice. The role of these systems in modernizing the agricultural economy of the area is discussed. Results of field surveys provide the basis for discussions on the marketing system, the role of different people in the marketing chain and market information and communication efficiency (through examination of price relationships in various locations).

- GOOD, C.M., 1970, Rural Markets and Trade in East Africa. A Study of the Functions and Development of Exchange Institutions in Akole, Uganda, Res. Paper, Dept. Geog., Univ. of Chicago, No. 128, 252 pp.

This is a comprehensive study of the functional role of market places in one area of Uganda. The study is in two parts. Part I deals with the timing and functions of the market places. Spatial distribution of markets relative to each other and to patterns of settlement and communication are examined. A profile of traders is developed from 900 interviews and a further 1300 interviews of consumers attempts to explain their spatial behaviour. The organisation of the markets in the area is described and evaluations made of the temporal/functional hierarchy of markets and consumer methods of travelling. Part II describes the history of market development and the results of various stimuli on the market system over the past 70 years (such as European administration).

- GOPALAN, K., 1967, Report to the Gov't of Nigeria; Marketing of Selected Agricultural Products in the Western Region, with particular Reference to Staple Food Crops. FAO, EA-UNDP/TA 2372, 19 pp.

- GULLIVER, P.H., 1962, The Evolution of Arusha Trade. In: Markets in Africa, Bohannan and Dalton (eds.)

- GUILLARD, J., 1965, Golonpoui; an Analysis of the Conditions of Modernisation in a Village in Northern Cameroon. Mouton and Co., Paris.

The book reports on a comprehensive survey of the natural, social and agricultural aspects of the Toupouri society in Northern Cameroon. The Agricultural economy is dealt with in considerable detail.

- HASWELL, M.R., 1953, Economics of Agriculture in a Savannah Village. Gt. Britain, Colonial Office, Col. Res. Stud. No. 8, London.

- HILL, P., 1966, Landlords and Brokers: A West African Trading System. Cah. d'Etudes Africaines, Paris, vol. 6, No. 3.

- _____, 1966, Notes on Traditional Market Authority and Market Periodicity in West AFrica. NISER Publ. No. 39.

- _____, 1969, Aspects of Socio-Economic Life in a Hausa Village in Northern Nigeria. Rur. Africana, East Lansing, Michigan, (8) 25-36.

Reports on a detailed socio-economic study carried out in a single Hausa village in Northern Nigeria. Some emphasis is placed on the reasons for the economic inequality of farmers within the village. Special attention is given to three areas: preferred farming systems, financial transactions as basic to economic life, and marketing of produce. Few formal markets were found to exist. Most transactions were in kind between farmers and traders.

- _____, 1970, Studies in Rural Capitalism in West Africa. Cambridge Univ. Press, Afr, Stud. Series 2, (23) 173 pp.

Studies of six indigenous economies are presented in some detail. The studies were done in Ghana and Nigeria by the author and include: cocoa farmers, fishermen, tobacco farmers, two studies on cattle herdsmen and trade, farms and farmers in a Hausa village.

- _____, 1972, Rural Hausa: a Village and a Setting, Cambridge Univ. Press, 368 pp.

The book is a socio-economic study of a single village in Northern Nigerian Hausaland, but it also contains a review of literature and a commentary on the general setting of the rural Hausa area. The main theme is economic inequality amongst individuals in the village and the chapters exmaine various aspects and results of this inequality. Price fluctuations within the village are discussed.

- HILL, P. & SMITH, R.H.T., 1972, The Spatial and Temporal Synchronisation of Periodic Markets: Evidence from Four Emirates in N.E. Nigeria. Econ. Geo. 48 (3) 345-555.

Empirical data was collected from four emirates in Northern Nigeria to test three hypotheses: 1) that because of the d m nance of the Islamic religion, a significantly larger proportion of the markets occur on Fridays, 2) that the periodic markets are organised such that those close in space are distant in time and 3) that there is a uniform dispersal of markets convening on the same day.

- JASNY, N., 1940, Competition Among Grains. F.R.I., Stanford, Calif.

- JONES, W.O., 1968, The Structure of Staple Food Markets in Nigeria as Revealed by Price Analysis. Fd. Res. Inst. Stud., Stanford, Calif. 8 (2) 95-123.

  Food marketing efficiency is evaluated primarily through analysis of price determinants. The marketing system for the four major commodity groups supplying food calories, was found to be significantly influenced by the inherent economic characteristics of the commodity such as its value, weight, or perishability. Five areas which differed in market features and in the elasticity of substitution between commodities, were studied, as well as seasonal price movements and spatial integration. The implications of the findings for other marketing systems in Africa are discussed.

- _____, 1970, Marketing Problems in Africa: Constraint on Agricultural Development. Dev. Digest, 8 (4) 95-107.

  This article is a digest of a paper presented at an AID-USDA seminar on Improving Food Marketing in Developing Countries, in 1970. It reports that a detailed study of African marketing systems (from several case studies), indicate the main problem to be a lack of wholesale traders able to deal on a country-wide basis. This, it is felt, significantly influences food distribution and agricultural production in a country.

- _____, 1970, Measuring the Effectiveness of Agricultural Marketing in Contributing to Economic Development: Some African Examples. Food Res. Inst. Stud., Stanford, Calif. 9 (3) 175-96.

  The author defines the stages necessary in passing from subsistence agriculture to complex divisions of labour and the effect this movement has or requires of the marketing system. He defines six areas of operation in which the market must be efficient if the agricultural economy as a whole is to be efficient: transportation, storage, information, market places, responsiveness and margins. Various African marketing studies are reviewed and evaluated according to these criteria. He finds the African marketing system generall adequate, but expresses doubt as to its ability to meet the changing requirements being brought about by the green revolution.

- _____, 1971, Farmers and Traders: Who Does What to Whom? Africa Report, 16 (3) 12-15.

  An effective rural marketing system should have two main characteristics: allow for accurate consumer-producer information flows and encourage farmers to use the market more and more for income and supply purchases. A list of commonly held, false assumptions about African rural markets is presented, followed by a discussion of the results of five Stanford Food Research Institute Studies in a number of African countries, carried out to test these assumptions. The studies showed that storage is not the problem it is believed to be. Seasonal increases in prices are moderate when the rate of return that capital can yield when invested elsewhere is considered. The studies also found that the average number of transactions from producer to consumer was usually lower than if a marketing board, etc. provided the marketing channel. Farmer and trader percentages of retail prices for various commodity costs are given. The effect of ethnic and tribal ties on the market are examined. The future prospects for rural marketing is discussed.

- KRISHNAMURTHY, K., 1970, Marketing and Storage of Food Grains in Kenya. Bull. Grain Tech. 8 (3) 121.

- LAURENT, C.K., 1969, A Background Appraisal of Marketing of Selected Agricultural Produce in Mtawara Region, Dar Es Salaam, Min. Agric. Fd. Co-ops.

- LAWSON, R.M., 1967, The Markets for Foods in Ghana. In: Readings in the Applied Economics of Africa, Vol. I, Micro Econ., Vol. II, Macro Econ. Cambridge Univ. Press, pp 173-92.

  Presents a review of an official report on "Inflation in the Consumer Markets in Ghana". Also describes the local produce and commodity markets in Ghana.

- LIVINGSTON, I., 1965, The Marketing of Crops in Uganda and Tanganyika. In: African Primary Products and International Trade. Edinburgh Univ. Press, pp 125-47.

  The article evaluates the criticisms and attempts to resolve the controversy over the efficiency of marketing systems in East Africa. The author concludes that much criticism has been misdirected: toward the farmer (because he lacks effective demand or economic constraints), toward the small trader and toward the economic rationality of African growers. He cites evidence of need for better checks on produce transactions. Problems in instigating and maintaining adequate checks including costs and black markets are discussed.

- MAINET, G.& NICOLAS, G., 1964, The Gulbi de Maradi Valley. A Socio-Economic Enquiry. Paris: IFAN, CNRS.

  Includes discussions and data on the rural economy, rural sociology, agriculture, nutrition, labour and traditional life styles of Nigeria.

- MAN, 1969, Hidden Trade in Hausaland, vol. 4 (3).

- MANIG, W., 1975, Price Movements of Grains and Their Impact on Marketing in Ethiopia, Exemplified by the Baco Area. Z. Ausl. Landwirtsch 14 (1) 68-86.

- MARCHES TROP. ET MEDIT., 1970, The Nigerian Market. Special Issue on the Republic of Niger. 26 (1301) 1-63.

  The first of three parts of this article describes the geography, history, demography and economy of the Niger Republic. Ten pages deal with crop production and five with livestock. Part II of the report describes the economic infrastructure and part III, the marketing structure of Niger, including the demand for foodstuffs.

- _____, 1970, The Togo Market. Paris, 26 (1308) 3455-528.

  An economic and administrative description of Togo is presented. The subjects are treated under special sections and include, economic and agricultural structure, transport and foods.

- _____, 1971, The Trade of the Cameroun Republic, Second Part, I, Natural Resources. 27 (1325) 848-79.

- MARCHÉS TROP. ET MEDIT., 1972, The Tropical and Mediterranean Products. 28 (2415) 3625, 3627-778).

  Two hundred and forty African agricultural products are discussed with regard to methods of production, marketing and principal uses and markets. The more important products are dealt with in sections of 3-12 pages in length.

- MARSHALL, G.A., 1963, The Marketing of Farm Produce: Some Patterns Among Women in Western Nigeria. Nig. Inst. Soc. Econ.Res., Conf. Proc., March 1962, Ibadan.

- MARTIN, A., 1963, The Marketing of Minor Crops in Uganda. In: Overseas Res. Publ. (1) 1-78, London.

  A 1961 survey of production of crops, including maize, millet, sorghum and pulses, is given, along with projections for their expansion. Methods of marketing these crops are discussed. The author concludes that increased production of these crops will not influence Uganda's world trading position, but would still be of value as far as local consumption is concerned.

- MASCARENHAS, A.C. & MBILINYI, S.M., 1968, Research of Subsidiary Staple Food Marketing in Dar Es Salaam. Univ. Coll. Econ. Res. Bur.

- McKIM, W., 1972, The Periodic Marketing System in N.E. Ghana. Econ. Geo., 48 (3) 333-44.

  An overview of the agricultural economy of one area of Ghana in which three centres from a focus for the trade is presented. The markets in the region are periodic in nature. Data collected on their spatial and temporal patterns is discussed and the author concludes that a five level hierarchy exists among these markets. A description of the organisation of, and movement between markets of the various people involved in the structure is presented. He concludes that the pattern of movements of traders gives rise to the structure and meaning of the periodic marketing system.

- MEDANI, A.I., 1970, The Supply Response of African Farmers in Sudan to Price. Trop. Agric. Trinidad, 47 (3) 183-88.

  Results of a yield and acreage response function indicate that the acreage of crops have a positive correlation with price for that crop. Sorghum, groundnut and sesame appear to be especially closely correlated. All the crops studied had positive short-run price elasticities within the range of .09 for millet to 0.72 for groundnuts. Long-run price elasticities range from 0.36 for millet to 1.62 for groundnuts. In all cases, the long-run elasticities were found to be greater than the corresponding short-run relationship. From the results, the author concludes that economic analysis of farmer response to price in the Sudan is possible.

- _____, 1972, The Supply Response to Price of African Farmers at Various Stages of Development. Oxford Agrarian Stud. 1 (1) 57-66.

- MIRACLE, M.P., 1968, Market Structure in Commodity Trade and Capital Accumulation in West Africa. In: Markets and Marketing in Developing Economies, Homeward, Ill.

- NISER Conference Proc., March, 1962, Marshall, G.A., Marketing of Farm Produce: Some Patterns of Trade among Women in Western Nigeria., pp 88-99.

- NISER Conference Proc., Marc, 1962, Hill, P., Some Characteristics of Indigenous West African Enterprise, pp 111-123.

- NISER, 1965, Documents Relating to the Organisation of Research on the Marketing of Staple Agricultural Products in Nigeria. Ibadan.

- NYANTENG, V.K. & APELDOORN, G.J. van, 1971, The Farmer and the Marketing of Foodstuffs. Tech. Publ. Series, Inst. Stats. Soc. Econ. Res., Univ. of Ghana, Legon, No. 19, 171 pp.

  An examination is presented of the major problems faced by Ghanaian farmers in marketing their produce and how these effect farmer's production decisions. The most serious problems are seen to be inadequate transport services and lack of storage at the market level. Several suggestions are made for improving the situation. The authors feel that improved road and vehicle servicing facilities and provision of adequate market place storage would both help the trader by reducing costs and risks and put the farmer in a better selling position by offering him alternative outlets.

- OLAYIDE, S.O., ET AL, /1972 A Quantitative Analysis of Food Requirements, Supplies and Demands in Nigeria 1768-85, Fed. Dept. Agric., Lagos, Ibadan Univ. Press.

- PANHUYS, H., 1972, Rapport au Gov't du Togo sur la Rationalisation du Marché des Cereales., FAO, ESR:TA/72/13, 34 pp.

  The report gives recommendations for a price stabilisation scheme and redistribution programme for cereals in Togo. Present production and marketing practices, problems of price fluctuations and supply and demand are reviewed.

- POLEMAN, T.T., 1961, The Food Economies of Urban Middle Africa. The Case of Ghana. Fd. Res. Inst. Stu., Stanford, 2 (2).

- REUSSE, E. & LAWSON, R.M., 1969, The Effect of Economic Development on Metropolitan Food Markets: a Cast Study of Food Retail Trade in Accra. East Afr. J. Rur. Dev., Nairobi, 2 (1) 35-55.

  The retail trade structure for home grown and imported foods is described. Evidence from other developing areas seems to indicate that in areas of rapid urbanisation, the retail markets tend not to keep up with rising populations.

This was found not to be the case in Accra, and descriptions of the new channels of trade are given. The most distinguishing features of the development in retail trade areas are: the important role public market places play, growth of "on the street" trade and traders, high sales of prepared foods, including bread and growth of a large supermarket-style trade.

- RHODES - Livingston Journal, 1962, Studies in Price Formation in African Markets. Vol. 31.

- ROURKE, B.E., 1969, Wholesale Price of Starchy Foods in Major Urban Centres of Ghana. Legon: Dept. Agric. Econ., Univ. of Ghana, 16 pp.

  Yearly price fluctuations, spatial price differences and seasonal price variations are analyzed for the period 1953-1969, for the major starchy foods sold in three urban centres of Ghana. The crops examined include, millet, sorghum and maize.

- RUTHENBERG, H. (ed.), 1968, Smallholder Farming and Smallholder Development in Tanzania. Munchen: Weltforum Verlag, 360 pp.

  Land, production, marketing and technological problems faced by farmers in ten selected areas of Tanzania are examined through a case study approach. Many of the studies deal with cash crop schemes only, but some also include evaluations of the food crop problems. The editor has written an evaluation chapter at the end of the publication. He found that skill and enterprise and not economic factors often caused the differences in performance of farmers.

- SCOTT, E.P., 1972, The Spatial Structure of Rural Northern Nigeria: Farmer's Periodic Markets and Villages. Econ. Geo. Worcester, Mass., 48 (3) 316-32.

  The attractiveness of various markets in an area was studied through the analysis of farmer and trader visitation patterns and trader movements. It was found that market periodicity seems more related to economic factors other than demand-density or religion. The importance of various markets seems also to be more related to the emphasis placed on a certain segment of the exchange system than to demand density. Unlike the south, cyclical market-ring patterns of trader or farmer movements did not exist. Only the poorest segments of the population appeared to visit more than two markets regularly. Wealthy traders operate generally in one market only and wealthy farmers regularly visit two markets if one is an evening market. It was found to be economically infeasible to visit many markets. Often traders will visit farmers, thus reducing the amount of travel necessary for the exchange of goods.

- SHAH, F.A., 1968, Losses in the Marketing of Agricultural Products. In: Nat. Training Centre on Agric. Marketing, Libya, Lecture No. 22, pp 153-161.

- SICILIANO, L., 1966, A Preliminary Survey on Grain Marketing and Existing Silos of the Somali Republic. UNSF Grain Marketing - Storage and Price Stabilisation Project, 37 pp.

  Most of the report is devoted to a description of the market situation as it exists. A general discussion of cultivation practices for cereals in Somali is given followed by a detailed discussion of the operation of the cereal market,

including: organisation, storage facilities during the marketing process, costs of the market process from the farm gate up and statistical information on average prices, price differences over space and time and net profits of wholesalers and retailers. The existing silo and warehouse facilities are described and the costs of transport ascertained. A description of price movements and market operation is given for the first half of 1966. Recommendations are made as to improving production, storage facilities, and training in cereal marketing, including storage and quality control techniques.

- SIMPSON, M.C., 1964, Notes on the Marketing of Agricultural Produce in the Shendi/Atbara Area. Khartoum Univ. Rur. Econ. Dept. Mem.

- _____, 1966, Khartoum's Food Supplies: A Study in the Production and Marketing of Six Basic Foodstuffs. Univ. of Khartoum, Fac. of Agric. 1966.

- SIMPSON, M.C., 1970, Marketing and Agricultural Development. J. Agric. Econ., Reading, U.K., 21 (1) 43-47.

  The author believes that agricultural marketing is lagging behind and impeding general agricultural development. The basis of this situation he sees as the unequal bargaining power of various segments of the marketing chain, which causes maldistribution of resources and loss of efficient pricing. He holds the structural organisation of the marketing system to be very important. Discussions are included of private enterprise, marketing boards and producer co-operatives in terms of institutions and structures in English-speaking West African countries and the Sudan.

- SMITH, M.G., 1955, The Economy of Hausa Communities of Zaria. HMSO, the Colonial Office.

- _____, 1965, Exchange and Marketing among the Hausa. In: Markets in Africa, Bohannan and Dalton (eds), N.W. Univ. Press, Evanston, Ill., ch. 11.

- SPLANSKY, J.B., 1969, Some Geographic Characteristics of Permanent Retail in Ankole, Uganda. In: Geo. Papers, Univ. of East Africa, Soc. Sci. Council Conf., 1968/69, Kampala: Makerere Inst. Soc. Res., 119-137.

  This paper reports on the results of a survey of retailing in Ankole District, Uganda. Two structures for retailing exist, rural markets and central places, which together account for close to 100% of the retail sales and services occurring. Central places are daily institutions, whereas rural markets tend to be periodic. The central places are discussed in terms of various characteristics including transportation, retail sales and retail services.

- STANFORD RES. INST., Marketing of Staple Food Crops in Tropical Africa, AID Project No. J-48.

- STORM, L., 1973, Rapport au Gouvernement de la Haute Volta sur l'Amélioration de la Commercialisation des Céréales, FAO/UNDP, No. AT 3197.

  This report deals with improving cereal marketing in Upper Volta. The study primarily consists of detailed cost breakdowns of various links in the marketing chain for

millet and sorghum, by district. Costs of importation from Niger and the U.S. are also analysed. Recommendations for improving the efficiency of the marketing system are then made, based on an analysis of the cost factors.

- SUDAN, 1963, Internal Marketing in the Sudan, J. Commerce and Ind., Khartoum, No. 49, Dec.

- SUDAN, Khartoum's Food Supplies. Res. Bull, Dept. Rur. Econ., Univ. of Khartoum, No. 2, 196 pp.

  Questionnaire surveys were conducted in all segments of the Sudanese food marketing system, from producer to retailer, in an attempt to explain the price discrepancies between producer and consumer. The survey was done for six commodities, including sorghum. Results are presented and suggest that the present marketing system provides producers with neither sufficient incentive nor profit for encouraging modernisation and increased production. They recommend further research into the ultimate end of profits realised by distributors.

- TEMPLE, P.H., 1969, Kampala Markets. In: Geog. Papers, Univ. East Africa, Soc. Sci. Council Conf., 1968/69, Kampala: Makerere Inst. Soc. Res., pp. 151-169.

  The results of a 1946 survey of Kampala markets are presented and compared to a more recent survey in an attempt to describe the evolution of the markets compared to the growth of the city. Analysis of various market characteristics, operational activity and origins and means of transport are made and compared with the first survey. Market sellers are also examined.

- THODEY, A.R., 1969, Marketing of Grains and Pulses in Ethiopia. Stanford Res. Inst., Rep. No. 16, SRI Project IU-6350, 271 pp.

  The population of Ethiopia depends on teff, maize, sorghum, wheat and barley for 50% to 75% of their calorie intake. This study reviews the demand projections for grains and pulses, analyses the existing market system and presents recommendations for improving the system. A detailed description is presented of the market organisation, types of merchants and markets, flow of produce, storage at various levels, transport and governmental organisations and policies dealing with the market structure. Price determination for various commodity classes, commodity price relationships, seasonal and cyclical price movements, spatial price fluctuations and margins and costs of various sections of the market structure are also analysed. The last half of the report presents recommendations for improving the system and the various problems identified in the first part, including such items as reorganisation of government bodies and co-operatives, storage and buffer stocks, processing, grades and standards, transport and information flow.

- UCHENDU, V., 1967, Some Principles of Haggling in Peasant Markets. Econ. Dev. and Cultural Change, 16 (1).

- U.K., 1967, Readings in the Applied Economics of Africa. Cambridge Univ. Press, Vol. I and II.

- USAID, 1970, Marketing Problems as Constraints on Continued Agricultural Development. USDA/USAID Seminar on Improving Food Marketing in Developing Countries, June 18-19, 1970, Wash.

- U.S., 1963, Basic Data on the Economy of the Islamic Republic of Mauritania. Overseas Business Reports, OBR-63-6, Jan., U.S. Dept. of Commerce

- VERHAEGEN, G., 1968, The African Peasant: "Traditional Man or Economic Man". Cah. Econ. Soc. Kinshasa, 6 (1) 100-27.

  Part I presents a summary of monographs on peasant farmer reactions to development projects, followed in Part II by explanations of factors influencing the peasant and the way he views development projects. These include, among others, poor communications and expensive markets, which encourage the farmer to make sure he has enough for himself, i.e. subsistence. Peasant farmer reaction to price fluctuations are more pronounced than previously thought, and the utility of money is very often low. The author concludes that possibly, investment in price stability, credit, transport and information may be of more use to development than investment in factors of production.

- WATT, M.J., 1969, Grain Storage and Marketing in the Somali Republic. Trop. Stor. Prod. Info. (18) 25-32.

- WILLIAMS, J., 1970, Sudan - Final Draft Report to Project Manager, AGS-UNDP/SF SUD/14, RESTRICTED.

2. Governmental.

(i) Marketing Boards, Exports, Price Controls, etc.

- ABBOT, J.C. & CREUPELANDT, H.C., 1966, Agricultural Marketing Boards, Their Establishment and Operation. FAO, Marketing Guide, No. 5, 236 pp.

  This book is fundamentally a guide on the practical considerations for establishing and operating marketing boards in developing countries. At various points in its text it presents concrete examples from established marketing boards in Africa for illustrative purposes. Apart from that it is a theoretical publication.

- _____, 1969, La Stabilisation du Marché Interieur des Céréales de Base: Leçons a Tirer de l'Experience Acquisé dans les Pays en Voie de Développement, FAO, Bull. Mensuel, Econ. Stat. Agric., 18 (2), 9 pp.

- ABBOT, J.C., 1971, Case Studies of Advances in Marketing in Tropical Countries. In: Proc. 14th Int. Conf. Agric. Econ., Oxford: Inst. Agric. Affairs, pp 468-77.

  Emphasis is placed on the need for carrying out, and building up, a collection of case studies on marketing in tropical countries to provide guidance for improving market processes, as aids for training market personnel and to show the close relationship of marketing to production. A review of case studies covering export and domestic marketing of food grains, co-operative marketing and expansion of specialised marketing channels and government marketing services.

- ADEJUNMOBI, E.O., 1970, An Analysis of the Movement of Urban Food Prices in Nigeria, 1954-65. Nig. J. Econ. Soc. Stud., Ibadan, 12 (1) 133-40.

It was recognized that improved storage facilities and more effective transportation and communication systems would be needed to adequately meet the irregular, but increasing demands for food in the urban centres of Nigeria. This paper reports on efforts to assess the level of success of suppliers in achieving these goals through an analysis of the food price movements in Lagos, Ibadan, Enugu and Kaduna between 1954 and 1965. The study found that although the prices in all centres fluctuated concurrently, the absolute price levels in Lagos were relatively higher. The author concludes that communication did improve over the time period but that storage facilities were still inadequate, transport to Lagos inefficient and trader assessment of demand levels for food was poor.

- CHARBONNEAU, R., An Enquiry into Marketing in Senegal. Marchés Tropicaux et Méditereanéens, Paris, 20 (989) 2464-93.

Information is given on the place of cereals and groundnuts in the Senegalese economy. Problems of marketing these products and the work of the Office de Commercialisation Agricole receive priority in the discussion. This office is involved in marketing controls and agricultural inputs supply. Information is also given on communication and transport problems and industrial development, among other things.

- COLLINS, H.C., 1975, The Less Developed Countries and Higher International Grain Prices Statistics. FATUS (Foreign Agric. Trade, U.S.) pp 91-96.

- CREUPELANDT, H., 1968, Study Report on the Possibilities of Introducing a Price Stabilisation Programme for the Principal Staple Cereals in Chad with the Help of a Contribution from the WFP., FAO, 28 pp.

- CREUPELANDT, H., 1971, Proposals for the Improvement of the Marketing of Grains and Pulses. Report to the Govt. of Lesotho, FAO, No. TA 3025, ESR:TA/71/15, 22 pp.

- DOGGETT, H. & JOWETT, D., 1964, Sorghum Breeding Research. East Afr. Agric. For. Res. Org., Record of Res. for 1st Jan. to 31st Dec. pp 112.

Improved varieties of sorghum are now being produced in larger quantities and grain processing and marketing need further investigation. Some excellent flour samples have been produced. Properly milled sorghum flour will have a useful market in East Africa, but an export market for the grain is desirable. Australia can export sorghum grain profitably to the U.K.; it should be possible for East Africa to do the same.

- EXPERIENCE INCORPORATED/USAID, 1966, The Ethiopian Grain Corporation; an Analysis of Past and Present Operations with Recommendations for Future Operations. Unpublished report; Addis Ababa.

- EXPERIENCE INCORPORATED, 1972, Feasibility of Producing Cereal Grain Crops for the Export Market.

- FAO, 1964, Report on Studies in Selected African Countries on the Usefulness and Feasibility of Establishing or Strengthening Price Stabilisation Schemes for Basic Food Grains with the Help of World Food Programme Stock, Rome. Plus individual studies, including, among others: Dahomey (Creupelandt), Libya (Bethke and Wilcox), Niger (Creupelandt), Tanganyika (Bethke and Wilcox).

- FAO, 1964, Government Measures to Promote the Transition from Subsistence to Market Agriculture in Africa. Rep. of FAO/ECA, Addis Ababa.

- FAO, Econ. Anal. Div., 1966, Rep. of the FAO Seminar on: Operation and Management of Marketing Boards in Africa. Ibadan, Nigeria, 11-30 July, 1966, 84 pp.

- FAO, Econ. Anal. Div., 1967, Operation and Management of Marketing Boards in Africa. Rep. of the FAO Seminar on: Ibadan, Nigeria, 74 pp.

- FAO, 1970, Establishing Market Information Services, Vol. 10.

- FAO, 1971, Survey of Export Markets for Sorghum. Commodity Bull. Ser. No. 49, pp 1-40.

Sorghum is grown mainly as a food crop and little reaches the export market in world trade; if it does, it is usually as a feed grain. This report analyzes the history of demand and supply factors for sorghum in world trade. Factors affecting the outlook for import demand and export supplies in selected areas are discussed. An outline is given of special technical and economic factors to be considered by countries contemplating entering the export market.

- FUGGLES - COUGHMAN, N.R., 1964, Agricultural Change in Tanganyika, 1945-60. Food Res. Inst., Stanford Univ., 98 pp.

The following subjects are discussed in the report: history of agricultural and related development, changes in marketing systems and farmer production and incentives to change. In addition, some recommendations are made for realizing the potential agricultural output, including governmental intervention in market organisation.

- HALLER, A.A., 1959, Kenya's Maize Control - A Rejoinder to Mr. Miracle's Article. East Afr. Econ. Rev., 6 (2).

- HESSE, G.F., 1968, West African Marketing Boards and Their Significance for Development Policy; Examples, Ghana and Nigeria. Hamburg: Univ. of Hamburg, 225 pp.

The history and characteristics of agricultural marketing in West Africa are discussed. The role of marketing boards within this system and their relationship to policy, exports and development are critically assessed. The marketing boards under question do not deal with cereals or pulses. The conclusion is reached that the structure and operation of marketing boards as they now exist, can contribute to development, but their absolute economic efficiency is questionable.

- JOHNSON, G.L., 1968, Factor Markets and Economic Development In: Econ. Dev. of Trop. Agric., Univ. of Florida Press, pp 93-111.

  A description of the operation of Nigerian agricultural factors is given, markets and the tendency to overuse factors of production in developing countries are discussed, as well as the actual and needed structural changes in the factor market and in related policy areas. The author believes the principal problem to the operation of these markets is the heavy taxation and other governmental policies which hinder investment in agriculture. He feels that structural changes are required in the credit and land and labour markets and that new technologies must be introduced if development is to progress.

- JONES, W.O., 1962, Consumption of Exotic Consumer Goods as an Indicator of Economic Achievement in Ten Countries of Tropical Africa. Fd. Res. Inst. Stud.

- KAINZBAUER, W., 1968, Trade in Tanzania. Afr. St., IFO-Inst. Wirt. -Forsch, Munchen, No. 18, 239 pp.

  The large majority of this report on trade and marketing deals with agricultural marketing of crop, animal and timber products. Discussions and data are presented on the production, marketing systems, marketing costs and marketing organisations, including the NAPB.

- KARRAR, S., 1966, The Markets for Sudan's Agricultural Produce (With Reference to Diversification of Agricultural Products). Proc. 13th Ann. Conf. Phil. Soc., Sudan (2) 255-69.

- KYESIMIRA, Y., 1969, Agricultural Export Development, Nairobi: East Afr. Publ. House, 100 pp.

  An examination is made of the role of the twelve agricultural commodities (which make up 80% of East African total value of exports) in capital formation. The author recommends emphasis be placed on diversifying the range of agricultural exports.

- LAMADE, W., 1968, Marketing Boards in Tanzania. Z. Ausl. Landw., Frankfurt a.M., 7 (4) 334-48.

  The twelve commodity boards existant in Tanzania are reviewed and classified (according to their functions and mode of operation) into four groups. However, even within these loose groupings, wide variations were found in their marketing channels and operational methods for such functions as buying, selling, producer payment, and price fixation. This heterogenity is seen as being one of the main problems to the efficient working of the marketing boards system. Recommendations to overcome these difficulties are presented.

- MAITRA, P., 1967, Import Substitution Potential in East Africa. Occasional Paper No. 2, Nairobi, Oxford Univ. Press.

- MARCH. TROP. MEDIT., 1969, The Algerian Market, 4th Part, Chapter I, Food Products and Tobacco. Paris, 25 (1231) 1723-31.

  This article discusses imported foods (including cereals and cereal products) as they relate to consumption goods. Quantities, origin and price of imports, and total internal production and/or consumption figures are given.

- MIRACLE, M.P., 1970, Markets and Market Relationships. Part 2, African Urban Notes, East Lansing, Michigan, 5 (3) 1-157.

  This publication is a collection of eight papers dealing with internal African markets and market relationships. Studies presented include: staple food markets in Kenya and the influence of capital and institutional (marketing boards) restraints, analysis of the influence of marketing institutes other than marketing boards in Kenya and Tanzania, an evaluation of co-operatives in Ghana, a study on the transporters' association in the Ivory Coast and the traders' response to this, and other changes in the economy since 1950, an analysis of 10 years of change in urbanisation and transportation and the traders' response to it in the Lower Volta area of Ghana, and on consumer responses in Enugu markets just before the Nigerian Civil War.

- NIGERIA, 1960, Estimates of Exportable Surpluses of Grains, N.E. Nigerian Gov't., Railway Extension Rep.

- OLAKAMPO, O., Distributive Trade - Critique of Government Policies. Nig. J. Econ. Soc. Stu. 5 (2).

- OTT, C.U., 1971, L'office de Commercialisation Agricole du Dahomey. Rap. au Gov't Dahomey, FAO, ESR. AT/71/4 No. AT2986, 28 pp.

- PANHUYS, H., 1973, Le Problème de la Commercialisation des Céréales. Rap. au Gov't Mali, FAO, No. AT3157.

  Examines the existing grain price system and makes recommendations for Governmental control, etc. The actual situation as to cereal production in Mali is reviewed along with the structure and operation of the OPAM (l'Office des Produits Agricoles du Mali), including its policies for price fixing and a discussion of marketing in the private sector. Recommendations for reorganisation of the OPAM, and on importation and transport policies are made.

- SARMA, M.T.R., 1973, Some Thoughts on Take-over of Wholesale Trade in Food Grains. Margin, 5 (4) 163-170.

- SCHUBERT, B., 1970, The Marketing of Basic Foodstuffs at the Beginning of Urbanisation and Industrialisation. The Case Study of Jinga, Uganda, Informationsdienstkartei (AGLBO) No. D-72-00784, Bonn.

- SHEIRA, A.Z., 1968, Inter-industry Relations in North Africa. Agric. Econ. Bull. Afr., Addis Ababa, (10), 27-48.

  This study examines the supply anddemand relationships between agriculture and other industries providing inputs and using outputs. This includes an analysis of the effect of demand for agricultural goods on the output of other sectors and the effect on agriculture of increased demand in other sectors.

- UNDP (Special Fund), 1967, Plan of Operation, Somalia; Grain Marketing, Storage and Price Stabilisation.

- USDA/AID, 1970, The Marketing Challenge. Proc. Conf. in Wash. D.C., June 18-19.

- WHETHAM, E.H. & CURRIE, J.I., 1969, The Economies of African Countries. Cambridge Univ. Press., 288 pp.

  This book examines production theory as it relates to African agriculture on the farm level and then on the commercial level. In Part II, the theory of supply and demand is applied to African local markets and international agricultural produce markets.

- YASSIN, M.M., 1966, The Influence of the Diversification of Agricultural Production on Marketing Structures in the Sudan. Proc. 13th Ann. Conf., Phil. Soc. Sudan (2) 133-52.

- ZAJADACZ, P., (ed), 1970, Studies in Production and Trade in East Africa. Afr. Stu., IFO, Inst. Wirt. -Forsch, Munchen, No. 51, 441 pp.

  This volume is a collection of papers dealing with the production and trade of Uganda, Kenya and Tanzania. The articles include: "Policies of Marketing Boards in East Africa." (Lamade, W.) and "Channels of Distribution in Uganda." (Laumer, H.).

(ii) Co-operatives and Credit

- ADAM, F.H., 1973, The Co-operative Sector in the Sudanese Economy. Univ. of Khartoum, Fac. Agric., Dept. Rur. Econ. Res. Bull. No. 22, pp 85.

- ANDERSON, P., 1968, "New System" in Niger. Afr. Rep. Wash. D.C., 13 (8) 12-17.

  Reports on a new method of agriculture credit to smallholders tried by the Union Nigerienne de Credit et Cooperation in Niger. Most of the credit operations were handed over to the farmers themselves on a village basis, and the old credit agents were converted into teachers. Repayment rates went from 12 to 75% up to 97% under the new system.

- ANSCHEL, K.R., BRANNON, R.H. & SMITH, E.D. (Eds.), 1969, Agriculture Co-operatives and Markets in Developing Countries. New York: Frederick A. Praeger; London: Pall Mall Press, 373 pp.

  This publication contains papers presented at a seminar held at the Univ. of Kentucky in 1967. Several aspects of agriculture co-operative markets are dealt with on both a theoretical and a case study basis. Some of the relevant papers include: Agricultural Markets in West Africa (Miracle, M.P.); Agricultural Markets in British West Africa (Anschel, K.R.); Co-operative Experiences in Tropical Africa (Miracle, M.P.), Algeria (Fosten, P.), and in Nigeria (Eicker, C.K.).

- APTHORPE, R., 1972, Co-operatives in Rural Africa. J. Adm. Overseas, 11 (3), 150-61.

  This is a general article on the state of agricultural co-operatives in Africa. The author assesses and discusses the reasons why most co-operatives have not achieved the goals for which they were set up. A few recommendations are made.

- BAUMAN, H., ET AL, 1966, A Situation Report of Agricultural Credit in Nigeria., CSNRD-3, XXX, 393 pp.

  A description of the agricultural infrastructure of Nigeria is given and a regional analysis of agricultural credit institutions throughout Nigeria is made. The report covers the period 1960-65.

- B.D.P.A., 1966, Le Développement de la Région des Savanes dans le Cadre du Plan Quinquennial du Togo. Secretariat d'Etat aux Affaires Etrangeres Charge de la Co-operation Min. Econ. Rur. Togo, 164 pp.

- BELLONCLE, G., 1968, Agricultural Credit in French-Speaking African Countries South of the Sahara. Rome: FAO, 162 pp.

  Part I of the study reviews credit requirements for African agriculture in the Sahara and analyses the problems commonly experienced with credit and credit institutions in the area. Part II gives 18 country studies dealing with credit. Conclusions stress the fact that developing credit facilities is only one part of an integrated development programme of which agricultural extension and leadership training are also very necessary. It is recommended that credit facilities be aimed at the intervillage co-operatives which are to be created.

- BUISSON, M., 1968, Study of the Development of Agricultural Credit in Cameroon. Paris: Bur. Dev. Prod. Agric., (BDPA), 147 pp.

  Agricultural credit in the Cameroon is analysed as a part of the entire development scene, including: research, extension, training, supply and marketing. Problems, both direct and indirect, to credit development are seen as a lack of trained personnel, inadequate management, lack of understanding of what credit means, and poorly organised trade channels. Recommendations for improvement and reorganisation based on the analysis are given.

- CAMPBELL, W.K.H., 1946, Report on Co-operative Possibilities in the Sudan., McCorquodals.

- CEA-FAO, 1970, La Co-operation et le Commerce Intra-sous-regionaux en Afrique de l'Ouest dans le Secteur de l'Agriculture. Vol. I, 239 pp. et annexe V, 280 pp.

- DIGBY, M. and McCREADY, K.J., (eds), 1970, Yearbook of Agricultural Co-operation, 1970. Oxford: Basil Blackwell, 280 pp.

  This publication consists of a lengthy collection of papers dealing with co-operative enterprises in both developed and underdeveloped countries of the world, as well as co-operative theory and general co-operative problems. Included amongst the papers are: Course on Credit and Marketing

for Developing Countries. (A Comparison of market structures for agricultural produce in developing countries), (Whetham, E.H.); Co-operative Movement in Nigeria, (Laditan, A.A.), and The Co-operative Movement in Upper Volta, (Gosselin, G.).

- EL DAFFALA, F.Y., 1964, Agricultural Co-operatives in the Sudan. Ubersee Rundschan, Hamburg, 16 (8) 1-46.

  The article is a review of the Sudanese Co-operative development from eight sccieties in 1948 to 800 in 1963. The author lists and explains the types of co-operatives found: pump scheme irrigation, mechanical production, consumer, milling, mechanical ploughing and threshing, supply and marketing and credit societies. He also notes some of the problems of these societies as, lack of leaders, illiteracy, transport difficulties, unstable prices, small capital and strict loan regulations.

- E.P.T.A., 1965, Report to the Government of the Federal Republic of Cameroon on the State of the Co-operative Movement. EPTA Rep. ILO No. R.7.

  The report includes an assessment of the problems faced by the Cameroon Co-operatives and makes a number of recommendations for priority development of marketing co-operatives, agricultural credit and supply of equipment and chemicals to farmers.

- FISCHER, P.H., 1970,Co-operatives in West Africa; Dahomey, Ivory Coast, Niger, Upper Volta. Voroff Inst. Genossenschaftswesen, Univ. of Marburg, No. 10, pp 14 and No. 39, pp 183.

  Conditions of agricultural co-operatives in the four West African Countries are reviewed and discussions on the range of problems they are facing, presented. The author draws conclusions as to the likely consequences.

- GORSE, J. & LARRIEU, C., 1968, Subsistence farming in the Wet Zone of South-East Mauritania. Possibilities for Development. Paris: Bur. Dev. Prod. Agric., 124 pp.

  A development programme to increase production of subsistence farmers in S.E. Mauritania (wet zone), by introducing improved cultivation, credit and organisation is reviewed. The study showed that strengthening and expansion of the present programme is necessary. Recommendations are made for achieving this aim, including: expanding credit facilities, pest control measures, and commercialising agriculture.

- GOSSELIN, G., 1969, The Co-operative Movement in Upper Volta. Geneve-Africa, Carouge - Geneve, 8 (1) 19-33.

  An examination is made of the development and organisation of co-operatives in Upper Volta. Five independent institutions are involved in the co-operative programme, some as production, some as credit and some as market organisations. Co-operative legislation is outlined and lists presented of various organisations providing credit facilities. The structures and development of the various types of co-ops. are described. Credit appears to be very easily obtained.

- JAWARA, D.K., 1963, The Role of Co-operatives and Ox-Plowing in the Rural Development of Gambia. Rehovoth, Aug. 1963, 3 pp. (Rehovoth Conf. on Comprehensive Planning of Agriculture in Developing Countries.)

- JENSEN, W., 1968, Agricultural Development in East Africa: A Review of 1967-68. East Afr. J. Rur. Dev. 1 (2) 72-88.

  A discussion of the early periods of and difficulties encountered by the East African Community (Kenya, Tanzania and Uganda) is presented. The economic performance of each country and of certain individual crops, including some cereals, is evaluated. A discussion is also given on such topics as, agricultural market co-operatives, mechanisation schemes, agricultural credit and agricultural education.

- JOHNSTON, G.L., 1966, A Situation Report of Agricultural Credit in Nigeria. CSNRD, Michigan State Univ.

- KHIDER, M. & SIMPSON, M.C., 1968, Co-operatives and Agricultural Development in The Sudan. J. Mod. Afr. Stud., London 6 (4) 509-18.

  This article provides a review of the co-operative movement founded by the government in 1948. Many of the 1000 registered societies have lost money or control of their society and the original £250,000 revolving credit fund was virtually gone by 1966. The authors feel that the main reason for the lack of success of the co-operative venture is the distrust by the farmers of the government heads and officials who run the co-operatives and the lack of agricultural knowledge of these officials. Recommendations for farmer leadership training and training of government officials in problems of agriculture are given.

- KINGBO, I., 1968, Credit in Agriculture, Abidjan: INADES. (Agric. Serv. Afr. Cours Perfectionnement Agric.), 55 pp.

  Agricultural credit is discussed in two parts: the first examines the goal of agricultural credit, different types of credit, whether or not credit can be replaced by some traditional means and why credit is necessary in developing agriculture. Part II examines how best agricultural credit can be adapted to the actual needs of agriculture in a particular area.

- KIRSCH, O.C., 1969, Types and Functions of Agricultural Co-operatives in Developing Countries. Heidelberg: Forschungsst. Ayrarstruktur, Agrargenossensch. Entevicklungs - Lander, 113 pp.

  This report represents part of an extensive contract with the West German Government. The results of a detailed examination of the Kenyan co-operative movement are presented. Areas covered include: establishment and operations of State Co-operatives, rural primary, secondary, tertiary and paraco-operatives, training of co-operative workers, current problems faced by the co-operatives and recommendations for future development.

- KOFFI, 1970, Le Mouvement Cooperatif et ses Problemes au Togo. Rap. de Stage Stencile, Lome, 82 pp.

- N'DIAYE, A., BELLONCLE, G. & DESROCHE, H., 1965, Co-operative Movement in Senegal, Dakar, ENEA.

  This fairly lengthy study is in three parts. Part I examines the organisations present before the co-operative movement; the welfare societies, rural production societies and rural development societies. Part II deals with the co-operative movement, its achievements to-date in

marketing and supply of equipment and other inputs, and its prospects. Part III includes a study of the problems in co-operative education, with recommendations for a co-operative college and the merging of the co-operative movement with the regional development assistance centres.

- NIGERIA, 1964, The Co-operative Movement in Nigeria. Nigerian Trade J., Lagos, 12 (3) 86-90.

  The article lists and discusses the various types of co-operatives and the progress they have made since 1960. Included are financial co-ops. in Lagos, thrift and credit societies in Lagos and Eastern Nigeria, and credit and marketing societies in Northern Nigeria. Also, the Western Nigerian Co-operative Union established 34 selling outlets and a supermarket.

- OLUWASANMI, H.A., 1965, The Adaptation of Modern Co-operative Structures to the Development of Nigerian Agriculture. Arch. Int. Soc. Co-op., Paris: pp 192-9.

  A discussion of the present weaknesses of agriculture in Nigeria and in the co-operative programme of development is presented.

- SAUL, J.S., 1971, Marketing Co-operatives in a Developing Country: The Tanzanian Case. Taamuli, Dar Es Salaam, 1, (2) 30-50.

  The author examines the effectiveness of agricultural marketing co-operatives in Tanzania. The study is primarily sociological and points out that the main problems of these co-operatives is the inefficiency and corruption, the lack of involvement of peasants in the co-operative and the simultaneous existence of subsistence and modernised farming methods. He recommends that the social prerequisites for co-operation be emphasized and developed.

- SOULET, M., 1968, Credit to Agriculture in the French-speaking Countries of Tropical Africa and Madagascar. C.r. hebd. Seanc. Acad. Agric. France, Paris, 54 (6) 407-16.

  A review of the role of international banks, local banks and mutual assistance and credit institutions in the agricultural economy of developing countries is presented.

- VASTHOFF, J., 1968, Small Farm Credit and Development. Afr. Stud., IFO - Inst. Wirt. -Forsch, Munchen, No. 33, 144 pp.

  A review is presented of the national credit systems of Kenya, Tanzania and Uganda and recommendations for improvements made. A section deals with statistical data on volume and sources of credit, purpose and the repayment pattern. The author found that credit is given on the basis of where it will be the most useful. Results of a survey of 108 farms in Kenya indicated that smallholder credit is very effective.

- ZILLICH, E., 1965, The Three Model Villages in Togo. Afrika Houte, Bonn., (12) pp 160-62.

  The article discusses the purposes, methods and success of a project aimed at increasing agricultural productivity and establishing rural industries in three Togolese villages. There appears to be a slowly growing interest in the co-operative idea from both the villagers and from other villages.

G. Utilisation

1. Traditional Processing and Nutritional Assessment

- LES PLANTES ALIMENTAIRES DE L'OUEST AFRICAIN: I. Adrian, J., Les Mils et les Sorghos. Valeur Alimentaire, Usage. II. Adrian, J. et Sayerse, Ch., Composition des Mils et Sorghos du Sénégal. Dakar, ORANA, 1954, (8) 167 pp.

- ADRIAN, J. & SAYERSE, C., 1957, Composition of Senegal Millets and Sorghum. Brit. J. Nut., 11 99-105.

- ADRIAN, J., 1962, Glucide Foods - Cereals. Quatrième Cours de Formation de Nutrionnistes de Langue Française en Afrique., Dakar, Sénégal, 10 Nov. 1961 - 15 Feb. 1962, 18 pp.

- ANDERSON, E. & MARTIN, J., 1949, World Production and Consumption of Millet and Sorghum. Econ. Bot., 3 (3) 265.

  Among a general review of sorghum and millet in the world, the authors give a brief description of uses made of these crops in Africa. Morocco exports sorghum stalks to Algeria for use in the broom industry and some grain to Europe as bird and chicken feed. In the Sahara Region, the grain is used for food and the stalks for fuel and building materials. In Ethiopia and Somali, for food and beer. In parts of the Sudan, millet is the chief food in the form of porridge and beer. In the savannah of Nigeria, sorghum is the main food in the form of porridge, dumplings and beer. The beer is rejected in favour of only porridge in dry years. In Ethiopia, sorghum is made into flour for porridge, while millet is used for beer.

- ARNOULD, J.P. & MICHE, J.C., 1971, Review of Utilisation, Processing, etc. of Millet in the World. Agron. Trop., 26 (8) 865.

- ARNOULD, J.P. & MICHE, J.C., 1971, A World Survey of the Economy and Utilisation of Millet and Sorghum. Paper presented at the Symposium on Composite Flours held in Vienna on 24 May 1971, ICC Study Group 32, 27 pp.

  A brief but fairly comprehensive review of the economy and utilisation of sorghum and millets throughout the world is presented. The first part of the paper gives an economic synopsis, including production trends, international trade, prices and their effect on import and export. The second section deals strictly with the uses of these two grains. Topics include: human food uses (generally in underdeveloped regions and stressing the large amount of manual labour involved in preparations), animal feeds, beer, syrups, broom sorghum, composite animal feeds, milling, both dry and wet (practically all the knowledge in this area comes from the U.S.). Mention is made of the potential for composite flour baking and of other industrial uses of sorghum and millet products and by-products.

- AYYAR, M.A.S., 1944, Sorghum Grain for Food. Planters' Chronicle, 39, pp 96.

- BONO, M., 1962, Food Values of Millets and Sorghums., CCTA/FAO Symp. Savannah Zone Cereals, 35.

- BONO, M. & VIDAL, P., 1962, Protein Content of Sorghums grown at the Centre of Agronomic Research, Bambey (Variations within the same Botanical Group in Relation to Grain Vitreousness). Agron. Trop. 17 (1) 67-74.

- BORASIO, L., 1937, Sorghum as a Food and as a Substitute in Fermentation. G. Risic., 27 (1) 7-12.

- BRESSANI, R. & RIOS, B.J., 1962, The Chemical and Essential Amino Acid Composition of 25 Selections of Grain Sorghum. Cer. Chem. 39 (1) 50-58.

- BURGESS, H.J.L., 1962, Cereal Foods Used in Uganda: 1. Millets and Sorghums. E. Afr. Medic. J. 39, 437.

- CHARAVANAPAVAN, C., 1954, Flour and Food Preparations from Sorghum, Maize and Kurakkan. Trop. Agriculturalist, 110 (1) 38-41.

- CULWICK, G.M., 1950, A Dietary Survey Among the Zande of the S.W. Sudan. Min. Agric., Gov't of the Sudan.

- CURTIS, D.L., 1965, Sorghum in West Africa. Field Crop Abstracts 18 (3) 145-52.

  A brief, but comprehensive review of sorghum in the West African Guinea and Savannah Zones is presented. The Taxonomy, classification and distribution of major sorghum varieties are examined along with a short history and description of present cultivation practices in different areas. Common diseases and pests and the average extent of damage from each are listed. The uses of the sorghum grain, stem and leaves are discussed. The grain is primarily used as flour or for beer. The preferred type of sorghum is generally a flinty type, which yields a white flour, although off-white flour is acceptable at times. Differences in protein content were found to be related to variety and flintiness, but is greatly influenced by climate and cultivation practices, i.e. fertilisation. Vegetative parts of the plant are used for construction, fuel or for fodder (immediately after harvest). One variety yields a purple dye from the leaves. An extensive list of references is given.

- DE SS, 1967, Traditional Foods - Their Present Production and Use. J. Nut. Diet., (4) 331-341.

- EAST AFRICA, 1941, Nutrition and Native Agriculture in East Africa. East Afr. Agric. J. pp 146.

- EDWARDS & CURTIS, 1943, Grain Sorghum, Their Production and Uses. Brochure des Bureaux de Agric. and Ind. Chem., March, pp 193-229.

- ELLINGER, K.R., 1968, Preparation of Agricultural Produce for the Market., Tripoli-Libya, 30 Sept. to 26 Oct., Lecture No. 4, pp 24-28.

- FAVIER, J.C., ET AL, 1972, Traditional Technology of Sorghum. Cameroon, Annales Nut. Alimen., 26 (6) 222-50.

- FAO, 1959, Domestic Utilisation of Coarse Grains. 11(1 & 2), pp A.4, Monthly Bull. Agric. Econ. and Stat., Rome, No. 10, pp 7.

  Lists countries participating in the survey and their main uses for the coarse grains; maize, barley, oats, sorghum, millet and mixed grains. Details on how coarse grains are used as foods, beverages and in industry are given. Lists seed requirements, waste and loss. Discusses feed use, grains fed directly and mixed in prepared feeds, composition of grains fed to livestock and individual types of livestock and their grain preferences and consumption.

- FAO - Nut. Div., 1960, Food Production, Food Habits and Consumption and Malnutrition. NU-MFG/WP/2, 17 pp.

- _____, 1962, Food Processing and Preservation in Africa. NU-INF. 3, 6 pp.

- _____, 1963, Food Processing and Conservation in Africa. NU-AMC/63/INF/A 5 pp.

- GAST, M. & ADRIAN J., 1965, Millet and Sorghum in Ahaggar. An Ethnological and Nutritive Study. Mem. Centre Rech. Anthropology. Prehistoric Ethnograph., (4) 1-78.

  Millet (Pennisetum glaucum) is the staple diet of 15,000 peoples of the Ahaggar (Haggar) region in central Sahara (Algeria). Descriptions of cultivation practices for millet and sorghum, milling procedures and meal preparation methods are given. A study of the milling methods as far as nutrition is concerned indicated that pounding in a mortar is the best of the local methods. The authors believe that milling can be mechanised on the village level. They pose the question: "Will it be possible to convince the younger people who are switching to wheat flour, that millet and sorghum are superior?"

- HORAN, F.E. & HEIDER, M.F., 1946, A Study of Sorghum and Sorghum Starches. Cereal Chem. 23 pp. 492.

- HUBBARD, J.E., HALL, H.H. & EARLE, F.R., 1950, Composition of the Component Parts of the Sorghum Kernel. Cereal Chem. 27 pp. 415-420.

- JOHNSTON, R.M. & RAYMOND, W.D., 1964, The Chemical Composition of Some Tropical Food Plants 1) Finger and Bulrush Millets. Trop. Sci. 4, pp 6-11.

  The paper gives the botanical sources and detailed analysis of the chemical composition of finger and bulrush millets. Both varieties grow well under semi-arid conditions, although finger millet tends to be more insect resistant during storage. Both varieties have a high food value in terms of the quantities of amino acids in the grain.

- KUMMEROW, F.A., 1946, The Composition of the Oil Extracted from 14 Different Varieties of Andropogon sorghum var. vulgaris. The Indian Oil and Soap J. 23, pp 273-75.

- LECLERCQ, P., 1962, Studies on the Flavour Properties of Sorghums and Millets. CCTA/FAO Symp. Savannah Zone Cereals, 13.

- LE MOIGNE, M., undated, Note sur la Transformation des Produits Vivrières. IRAT, Centre de Récherches Agronomiques de Bambey, Sénégal.

- LERICHE, A., 1949, Le Couscous, sa Preparation. Notes Afric., Bull. d'Inf. et de Correspondence de L'IFAN, Dakar, No. 44, pp 106-107.

- MILLER, O.H. & BURNS, E.E., 1970, Starch Characteristics of Selected Grain Sorghums as Related to Human Foods. J. Fd. Sci., 35 (5) 666-668.

- MULLER, H.G., 1970, Traditional Cereal Processing in Nigeria and Ghana. Ghana J. Agric. Sci., 3 (2) 187.

  The article describes the traditional milling processes using stone and mortar and pestle mills. A sieve analysis of traditionally milled sorghum and a flow chart for the milling operation is given. Flow charts are also given for the procedures used in preparing Kaffir beer, ogi, and koko porridges and Fanti "kenkey". A literature review of cereal products which include six beverages, seven porridges, ten dumplings and three baked or fried products.

- PARRISH, D.B., 1971, A Fresh Look at Millets: Nutritive Value of Ragi and Bajro Proteins. League for Int. Fd. Educ., Newsletter, Nov.

- ROONEY, L.W., GUSTAFSON, C.D. & SULLINS, R.D., 1970, Influence of Brown and Yellow Grain Sorghums on Attributes of Products from White Grain Sorghum. Cereal Sci. Today, 15 (7) 206-207.

- ROSS, W.M. & WEBSTER, O.J., 1960, Culture and Utilisation of Grain Sorghum. USDA/ARS Agric. Info. Bull. No. 218.

- SACHS, R., (ed), 1967, Beginnings of Agricultural Development in Ethiopia. Mater. -Samml. Z. Ausl. Landw., Frankfurt a.M. No. 7.

  The publication is a series of nine papers by post-graduate students of the Inst. for Overseas Dev. of the Tech. Univ. of Berlin. Section III contains a paper on the cultivation and use of millet.

- SIMMONS, E.B., 1973, The Economics of Consumer-Oriented Food Processing Technology in Northern Nigeria. Samaru Agric. Newsletter, 15 (2) 56-72.

- STECKLE, J. & EWANYK, L., 1974, Consumer Preference Study in Grain Utilisation, Maiduguri, Nigeria. IDRC. No. 022e, Ottawa.

- SUDAN, Report on the Uses of Sudan Dura (Dari). Cent. Intell. Brch., Cent. Econ. Bd., pp 1-24.

- U.K., 1913, The Utilisation of Sudan Dura., U.K. Imp. Inst. Bull. No. 11, pp 33-46.

- WATSON, S.A. & MOFFET, G.M., 1959, The Present Importance and Bright Future of Grain Sorghum. Cereal Science Today, 4 pp 230.

- WHITBY, P., 1968, Foods of Ghana. NU-UNDP/SF GHA/7, 32 pp., RESTRICTED.

- YOUSIF, Y.B., 1972, Nutritive Values of Sudan Foodstuffs. Sudan J. Fd. Sci. Tech. No. 4, pp 39-45.

2. Modernised

(i) Milling

- ADRIAN, J. ET AL, 1967, The Problem of Millet Milling; Nutritional Importance of African Village Methods and Attempts at Mechanisation. Agron. Trop. 22 (8) 687-98.

  In villages in Southern Algeria, pearl millet is usually mixed with 10-20% sorghum or Pennisetum cernuum grain, before milling. The mixture is made into semolina in mills with a bottom or rotary millstone, or pounded in a wooden mortar which yields, 55% semolina, 30% flour (protein layer plus aleuron and germ) and 15% bran. A hammer mill could produce an acceptable quality semolina from pearl of Panicum millet grain, not from mixtures. Analysis of the chemical composition of these products indicated that their replacement by wheat flour would result in a lower quality diet.

- ASSELBERGS, E.A., 1974, Report of the Processing of Wheat, Rice, Sorghum and Millet in Cameroon, Tchad and Central African Republic. FAO WS/E7796, 18 pp.

  The report deals with the situation of processing wheat, rice, sorghum and millet and the effectiveness of gov't policies related to these crops in terms of infrastructure, production, research, imports, price and institutional set-up. Each of the three countries is dealt with separately. Figures for wheat and rice production and imports, sorghum and millet production, wheat flour and bread production and brief cost analyses for milling and bread production are given for each country. The rice milling industry in each country is also discussed. Cameroon has built a wheat flour mill in Doualla, of 35,000 ton/year capacity. The gov't has studied the feasibility of using the mill also for sorghum and one bakery has experimented with composite flour for biscuit production. Recommendations for another poly-valent mill are discussed. A composite flour experiment using 30% sorghum - 70% wheat flour in Chad is described. Recommendations for further experiments are made and proposals put forward on starting a millet-sorghum mill in S.E. Chad, or converting the present wheat flour mill at Ndjamena to a poly-valent mill. Experiments have been made in Central African Republic on milling sorghum in their wheat flour mill, but it was found that additional cleaning and decorticating equipment would be necessary. The possibility of using sorghum and maize flours with wheat in baking is discussed briefly.

- BAKER, R.J., FARELL, E.P., 1961, Factors that Affect the Granulation and Capacity in Grinding Corn, Oats and Sorghum Grain with a Hammer Mill. Feedstuffs, (Minneapolis) 33 (13) 26, 29-32.

- CARNOVALE, E. & QUAGLIA, G.B., 1974, Influence of Temperature and Moisture Controlled Preservation on the Chemical Composition of Milling Products from Millet. Ann. Tech. Agric., Special No., pp 231-240.

- DOGGETT, H. ET AL, 1970, Grain Studies, Rec. Res., Ann. Rep., East Afr. Agric. For. Res. Org., East Afr. Comm. pp 33.

  Among listings of protein and lysine levels of 61 sorghum types, results of milling trials showed 25.9 to 43.3% of total protein was retained in the flour.

- FAO - Nut. Div., 1966, Report of the FAO Conference on Cereal and Bread Technology for the Near East Region. Cairo, UAR, 5-10 Feb.

- FAO, 1971, Current Situation - Milling and Utilisation. Agr. Econ. Bull. Africa, No. 13, pp 73-79.

- FAO, 1971, The Current Situation in Relation to the Milling of Sorghum and Millets and the Utilisation for Flour. Paper submitted to the Econ. Commission for Africa, Addis Ababa, by FAO Fd. and Agric. Ind. Ser., Agric. Ser. Div. Rome.

  The growing popularity of wheat and wheat bread in Africa is reviewed and the possibilities of replacing some of the use of wheat with locally grown millet and sorghum, examined. The milling characteristics of wheat are compared with those of sorghum and millet and a description of the basic milling techniques and machinery used in the Zinder flour mill project is presented. Discussions on fermented millet flour from traditional processes and attempts at duplicating the process in the mill are given. A second phase of the project is investigating the microbiology of fermentation and use of the flour in biscuits and pasta products. The establishment of an association of Sahel countries for introducing milling technology is outlined. The composite flour programme is discussed. Use of cereal flours in bread has not been stressed, but their use in biscuits and pasta products has been successful on a pilot scale. A common problem is the lack of uniformity of millet and sorghum flour quality. The millet-wheat bread flour project in Dakar is mentioned. A few recommendations are made on direction of further research.

- HAHN, R.R., Dry Milling of Grain Sorghum. Cereal Sci. Today, 14 (7) 234-37.

- INDUSTRIAL CO-OPERATIVE PROGRAMME, 1972, Report to the Gov't of Dahomey by the ICP Mission to Dahomey, 7-17 April, 1972, Vol. 1, 58 pp.

- IDRC, 1972, Grain Milling and Utilisation (West Africa), IDRC Reports 1 (2), 18.

  A grant was given to the Gov't of Nigeria to aid in developing an improved rural milling system for local grains using a successfully tested milling system developed in Canada. The scope of the project extends also to a study of the entire grains system, from production to consumption. The possibility exists of repeating the milling system throughout the Sahel Zone and in parts of S.E. Asia. The use of composite flours in breads and infant foods will also be studied.

- KAPASI-KAKAWA, J., 1974, Milling Trials on Sorghum Grain. 5th Eastern Africa Cereals Research Conference, Malawi, 7 pp.

- KURIEN, P.P. & DESIKACHAR, H.S.R., 1962, Studies on Refining of Millet Flours. I. Ragi (Eleusine coracana). Fd. Sci. May, pp 136-137.

  A trial was carried out to compare the nutrient composition of millet processed by three methods: dry milling, wet milling, and dry milling followed by wet processing of the residues. In the dry milling, it was found necessary to strengthen the husks by adding 5% moisture plus a steam treatment and cooling before milling. Milling was done in a Wiley Mill. Dry milling consisted of grinding, sieving the product, regrinding the residues and sieving again to give two fractions plus a residue. Extraction rates were approximately 70%. Wet milling gave a higher extraction rate (81%) but nutrient recovery was lower due to loss of solubles. Tables of protein calcium, phosphorus and thiamine recovery in the various fractions of all three processing systems are given.

- MOCQUARD, J., 1968, Development of the Industrial Processing of Millet and Sorghum in Niger. Nut. Newsletter 6 (2) 10-11.

  In this article, the setting up of a mill for millet and sorghum processing at Zinder in the Niger Republic is discussed. It has been technically designed to produce in the first instance, flours and semolinas from millet and sorghum for local consumption; at a later stage to provide flour processing industries, and finally to market the millet and sorghum products on a country-wide basis. The mill was constructed in 1966 and became operational in 1967. Grinding capacity is one ton per hour.

- PERTEN, H., 1970, Rapport d'Etudes de la Stabilité des Farines de Mil et Sorgho Produites par "Sotramil", Zinder, Niger, Rap. No. 56, 14 pp.

- RAGHAVENDRA, S.N. ET AL, 1964, Pearling as a Method of Refining Jowar and Wheat and its Effects on their Chemical Composition. J. Fd. Sci. & Tech., 1, 40-42.

- RAO, M.N., 1958, Effect of Milling on the Nutritive Value of Jowar (Sorghum vulgare). Fd. Sci. 7 (9) 254-55.

- RAYMOND, W.D., SQUIRES, J.A. & WARD, J.B., 1954, The Milling of Sorghum in Nigeria. Colonial Plant and Animal Products 4 (2) 152-58.

  Results of milling, chemical composition and consumer acceptance trials for two varieties of sorghum from Nigeria are reported. The milling and analysis took place in the U.K. Milling was done in a standard wheat roller mill with modifications to the fluting, differential roll speed and fineness of sieves. Proper tempering methods are outlined, and percentage composition of the end product to whole grain given. The mill was found to give satisfactory results and could be improved with simple modifications. Composite wheat - sorghum flour breads were examined and it was found that a maximum of 10% sorghum component made bread satisfactory. Proximate analysis, comparing laboratory and commercially milled sorghum is tabulated. Flour samples were sent back to Nigeria and consumer acceptance

trials in various dishes conducted. A detailed discussion of the results is presented. In general, the flour was found to be acceptable and nearly identical to the traditionally prepared type. A moderate infestation with tribolium occurred during storage and shipment of the flour.

- RIJNENBERG, J.H., 1963, Survey of the Milling Industry in Eight Republics of West Africa - Senegal, Mali, Guinea, Ivory Coast, Niger, Nigeria, Dahomey, Ghana. FAO Mission CEA de Co-ordination Industrielle pour les Pays de l'Afrique Occidentale, 26 pp.

- ROONEY, L.W., ET AL, 1970, Sorghum Quality Research. Sorghum Newsletter (13) 75.

  Results suggest that a medium large, white, corneous grain is best for dry milling from the viewpoint of grit yield, oil content of grits, and colour of product. Milling yield, density and hardness were closely related. Some yellow endosperm grains had excellent dry milling qualities. Wet milling studies suggest that varieties with a soft, medium large grain give the best starch recovery. Corneous endosperms have not got good wet milling characteristics.

- ROONEY, L.W. ET AL, 1971, Sorghum Quality Research. Sorghum News letter (14) 107.

  Dry Milling: Proportions of corneous flour to floury endosperm in sorghum grain kernels influenced milling yield and grit composition. Sorghum kernels with all floury endosperm shattered during milling. Grit yields were closely related to endosperm texture; rating ($r = 0.93$), hardness ($r = 1.89$) and density ($r = 0.74$). Prediction equations were calculated and offer the potential of being used by plant breeders to predict the milling performance of sorghum.
  Tannin Analysis: A suitable method of tannin analysis for use with sorghum grain appears to be an urea extraction followed by colour development.

- SENEGAL, 1963, Moulin Decortiqueur Eurofic E.S./Prototype A, Decortiqueur Conique. C.R.A. de Bambey.

  Two reports in 1962 and two in 1963, describe the machine and various trials conducted with it.

- SENEGAL, 1969, Use and Maintenance of the Huller-Cleaner M 164 for Millet and Sorghum. Ombre Baobab (16) pp 2, 8.

  This article describes the construction, functioning, use and maintenance of a small huller-cleaner developed for use by co-operatives in Senegal for millet and sorghum. The unit can be driven by either an 8 hp electric or a 10 hp petrol engine and has a capacity of 130 kg of millet or 120 kg of sorghum per hour. The extraction rates obtained were 85% for millet and 80% for sorghum. For best results, it is essential that the grain be dry before using the machine.

- SHEPHERD, A.D., WOODHEAD, A.H., ET AL, Sorghum Processing. East African Industrial Research Organisation, Annual Reports 1968-69 to 1973-74.

- STRINGFELLOW, A.C. & PEPLINSKI, A.J., 1966, Air Classification of Flours from Varieties Representing Different Hardnesses. Cereal Sci. Today, 11 (10) 438-40, 445.

- THOMAS ROBINSON & SONS LTD., undated, The Proquip Rotomill Centrifuge Machine, Model No. 30 - has a capacity of 4,800 lbs/hr. on fine ground materials and 5,000 lbs/hr. on granular materials - from manufacturer's notes.

  This machine is equipped with a rotor, whose centrifugal action causes such a severe impact that any living organism is destroyed. The "Rotomill" centrifuge allows flour mills, etc. to produce granular and powdered materials entirely free from insect pests. It also prevents development of insect infestation by destroying eggs, mites and larvae.

- VIRAKTAMATH, C.S., ET AL, 1970, Use of Rice Milling Machinery for Commercial Pearling of Grain Sorghum (Jowar) and Culinary Uses for Pearled Sorghum Products. J. Fd. Sc. & Tech. 8 (1), 11-13.

(ii) Bread

- ABERT, P., 1971, Fabrication et Commercialisation de Pain à base de Farines Composées au Niger. Rap. No. 63, 7 pp.

- AVANZI, E. & GRAFF, G., 1939, Flour from Sweet Sorghum and Maize in Fermented Bread. Industria Saccar. Ital., 32 (5) 273-278.

- BORASIO, L., 1933, The Use of Substitutes in Panicifcation. G. Risic., 23 (9) 193-212.

- _____, 1937, Le Sorgho Comme Aliment et Comme Succedane dans la Panification. Il Giornale di Risicoltura, 27 (1) 7-12.

- BUSHUK, W. & HULSE, J.H., 1974, Dough Development by Sheeting and its Application to Bread Production from Composite Flours. Cereal Science Today 19 (7) 424-427.

- DENDY, D.A.V., 1970, Composite Flours. Paper presented at the Sub Group Meeting on Food Industries and Marketing, 23 March.

  This paper presents a review of the tests and findings of the TPI at Culham, U.K. on composite flours. Initial work was done on cassava starch/wheatflour mixtures. They confirmed that the Chorley-wood method was superior to bulk fermentation processes, but found that hardened fat gave better texture than glyceryl monostearate. Work was also done on soya/wheat and coconut/wheat composites. The general conclusion was that flours and starches with high fibre contents are not suitable for composite flour breads. Millet flour from Senegal, mixed with a strong Canadian wheat, even at 10% gave a coarse textured, low-volume loaf, but with excellent eating qualities. A Sudan sorghum/strong wheat composite at up to 15% was made without significantly depressing loaf volume. The eating qualities were excellent, but the crumb slightly grey in

colour. They found that by using the Chorley-wood process, 10% sorghum could be added to Sudan wheat. Tests were also done with rice, yam and fish as well as other protein concentrates. It was concluded from a test of composite flours at 50% substitution in a commercial bakery that only small modifications to the commercial bakery would have to be made to obtain the same results of that in the test bakery.

- DENDY, D.A.V., JAMES, A.W. & CLARKE, P.A., 1971, The Use of Sorghum as a Diluent for Wheat Flour in Breadmaking. Sorghum Newsletter, 14 pp 22.

- FAO, 1968, Note on Mechanically Developed Doughs from Composite Flours. FAO/Ind. Co-op. Programme, IP/AGS:G/68/20.

  Mechanical dough development has the twin advantages of reducing the time needed for fermentation of bread doughs and allowing the use of much weaker wheat and flour blends if done in a batch process, besides allowing substantial economic savings. Testing of cassava starch, maize starch, soya, millet and sorghum flours and fish protein concentrates in various mixtures with Canadian wheat flour was undertaken by British Arkady Co. in the U.K., using a Tweedy mixer A, No. 10 or No. 35. Acceptable volume, texture, eating and keeping qualities were obtained from all the composite flours at a level of 30-40%. The formulae used are presented.

- FAO, 1969, Bread from Composite Flours. Agric. Ser. Bull. No. 4.

  The purpose of the paper is to introduce work on new baking technologies carried out in an attempt to raise the substitution percentage of non-wheat flour and starch for wheat flour in breadmaking from the approximately 10% possible with conventional baking techniques. T.N.O. in The Netherlands has developed a gluten replacer, glyceryl monostearate, with which a wide variety of starch and protein flour can be made into fairly conventional loaves. Work on extended wheat flour has shown that by using certain bread improvers, such as calcium stearoyl lactylate or diacetyl tartaric acid esters or high percentages of fat and sugar, composite flour loaves of acceptable quality can be produced using a high percentage of non-wheat flour. Some successful bread formulae using composite flours are presented. Mechanical development of bread doughs was found to allow the use of weaker wheat/non-wheat cereals and starches in fairly large proportions in bread doughs. High energy input into dough mixing takes the place of the conventional fermentation systems. Several processes including the Chorley-wood and Do-maker processes and high-speed mixers are now available. A table of successful composite flour bread formulae used with mechanical development is given.

- FAO, 1970, Meeting of the Sub Group on Food Industries and Marketing, Nutritional Aspects of Composite Flours. FAO/Ind. Co-op. Programme, DDI/ESN/AGS:G/70/11.

  The paper describes the results of two nutritional studies done by rat feeding trials, to compare the nutritional value of composite flour breads with conventional wheat bread. The first trial done by T.N.O., The Netherlands, compared cassava/soya, cassava/peanut and wheat breads.

They found that the cassava/soya bread had the highest protein quality and that the cassava/peanut bread was only slightly higher than wheat bread in protein quality. The second trial done at Queen Elizabeth College, London, using mechanically developed doughs of various mixtures and concentrations of cassava, maize, soya, millet, sorghum, and fish protein concentrate flour and compared to conventional wheat bread, showed that in no case was the protein value of composite breads lower than wheat bread and in some cases, was higher. The complete report of this second trial is to be found in the March 1969 issue of Cereal Science Today.

- FAO, 1970, Current Field Activities in Composite Flour Development. FAO/Ind. Co-op. Programme, Meeting of the Sub Group on Food Industries and Marketing. DDI/AGS:G/70/12.

  The paper gives a short summary of four FAO/UNDP projects which incorporate a composite flour programme. In Senegal, a cereal technologist and a baking technician are working for four months to determine technical and economic feasibility of composite flour, french-type loaves. Also, the Ecole de Boulangerie des Grands Moulins de Paris is working in composite flour utilisation in French bakery products. In Niger, a flour mill project in Zinder is to incorporate work on using composite flours of sorghum and millet from the mill in pasta and biscuits on a unit capable of processing 200 kg per hour. The mill has a capacity of approximately 2500 tons per year of raw material. In the 1968/69 year it produced 396 tons of millet flour and 758 tons of sorghum flour, both at 80% extraction. Major problems exist in supply of grains and consumer acceptability. In the Sudan, flour milling of wheat is fairly modern, but facilities for blending wheat flours and assessing their baking qualities are lacking. A cereal technology laboratory is being constructed at present to aid in remedying the situation. Projects on composite flours of potato, maize, cassava and wheat in Brazil and a proposed composite flour programme in Colombia are also discussed briefly.

- FAO, 1970, The Composite Flour Concept: A Scientific Approach to Satisfying a World Need. Meeting of the Sub Group on Food Industry and Marketing. DDI/AGS:G/70/13.

  The paper summarizes the basic facts learned since 1964 by the FAO Composite Flour Programme and reports on the directions decided on at a meeting at T.N.O., Wageningen in Feb. 1970, as to where composite flour research should be headed. To-date, the concept has been that bakery products from composite flours should be the same as those from wheat flour. Although composite flour products have come close, there are still differences in texture and palatibility to those of 100% wheat flour. The meeting decided that composite flour products, rather than attempting to replace wheat products, should be promoted on their own merits, that a synthetic gluten, for technical and economic reasons, is not feasible at this time, that further work into the nature of wheat gluten to facilitate synthesizing substitutes should be attempted and that possibly, biscuits from composite flours, rather than bread, may be more feasible.

- FAO, 1971, Blended Bread Helps Developing Countries Make Foreign Exchange Savings. FAO News Feature, NF/71/4, Nu/3, 2 pp.

- FURIA, R. di, 1971, Problèmes Economiques Concernant la Fabrication d'un Pain a Base d'un Mélange de Farine de Blé et de Mil - Sorgho. FAO, AGS:SF/SEN/64/505, Rap. Tech. No. 6, 13 pp.

- GHANA, 1942, Maize and Millet as a Substitute for a Percentage of the Wheat in Gold Coast Bread. Public Ledger, Dec. 14, pp. 1.

- QUINET, R. ETAL, 1970, Rapport Preliminaire sur les Travaux d'Essais en Panification en Utilisant la Farine de Céréales Sénégalaises en Mélange avec la Farine de Blé Importe. FAO, AGS:SF/SEN 5 No. 39, 15 pp.

  The paper reviews the work already done, problems encountered and proposed future direction of studies on composite flour products.

- GUINET, R., 1970, Rapport sur l'Avancement des Essais en Panification en Utilisant la Farine des Céréales Sénégalais Mélangee avec la Farine de Blé Importe. Rap. No. 52, 12 pp.

- HART, M.R. ET AL, 1970, Bread from Sorghum and Barley Flours. J. of Fd. Sci. 35 (5) 661-665.

  This study examines several additives used to aid in making sorghum and barley bread. A level of 45% solids allowed good rise. Gas retention and texture were improved with 4000 centipoise methylcellulose. Glyceryl monostearate improved texture, but caused crumbling and shortenings were found to soften the bread. Several starches were found to improve texture and loaf volume. The effect of different processing techniques were studied as well as two ways of producing a sour, fermented flavour in the bread.

- HULSE, J.H., 1967, Visit to the Institute for Cereals, Flour and Bread, T.N.O., 29 July - 3 Aug., 1967, FAO, NU-T/67/10, 9 pp.

- JONGH, G., 1970, Development of Composite Flours. A report given at the Sub Group Meeting on Food Industries and Marketing. March 23, 1970.

  A brief report is given on the extent of the composite flour research programme at the Inst. for Cereals, Flour and Bread, T.N.O., Wageningen, The Netherlands. They have produced a good loaf from 80 parts cassava starch and 20 parts defatted soya flour, as well as developing a procedure for the use of commercial equipment for baking the bread. They have also done work with sweet potato, maize, millet, sorghum and high protein cottonseed flour. Work on extended wheat flours showed that a good loaf could be made from 70 parts wheat flour, 25 parts cassava starch and 5 parts defatted soya flour.

- KILBY, P., Patterns of Bread Consumption in Nigeria, Fd. Res. Inst., Stud. Stanford Calif., 5 (1) 3-18.

  The study describes the demand for bread and the system for its distribution in Nigeria. An indication is built up of the nature of demand for all temperate foodstuffs.

  The study also tries to explain the popularity of bread, despite its higher relative cost. New consumer industries in relation to bread are discussed in terms of local supply rather than importation.

- _____, 1965, African Enterprise: The Nigerian Bread Industry. Hoover Inst. War, Revolution, Peace, Stanford Univ., 112 pp.

  The development of the bread industry and the pattern of bread consumption between 1959 and 1962 is evaluated. Descriptions of various baking techniques and factors of production are described and their relative efficiencies assessed. Distribution of products and elements of competition are also discussed.

- KIM, J.C. & RUITER, D. de, 1968, Bread from Non-Wheat Flours. Food Tech. 22 (7) 867-78.

  Using wheat starch, tests were conducted on the starch granule-binding ability of 20 different substances. Glyceryl monostearate emerged as a good binding agent. Comparisons were made of bread quality from various mixtures of 16 protein concentrates at 18-20% and yam flour. Moderate results were obtained from a cassava starch, soya bean or peanut flour composite. The effects of different proof times and mixing speeds on loaf volume and texture were compared. The non-wheat breads compared well with wheat breads in nutrition trials with rats.

- LAURENT, C.K., 1968, Agro-Industries in Nigeria. CSNRD, Rep. No. 25, 41 pp.

  This report represents a comprehensive census and assessment of the development patterns of agro-industries in Nigeria. The only cereal-based industries were milling and bakeries. Only six grain milling industries were included in the survey; one large wheat flour mill in Lagos and five rice mills. Sixty bakeries were included, (estimated to be 100 bakeries employing 10 or more people). Three firms produce 35% of the products and account for 20% of the employment. Grain milling employees were the highest paid of all agro-industrial workers and bakery workers, who are mostly self-employed proprietors, were the lowest paid. Gross economic data (capital expenditure, value added, etc.) is presented for each industry. Almost half of the industries (especially bakeries) started operation in 1959 or after. The author found that growth was slow in industries such as grain milling, where one or two firms dominate.

- MARTINEZ, R.V., 1952, Essais de Panification du Blé avec des Mélanges de Mil et de Mais. Agricultura Trop. (Bogota), (11), 31-39

- NIGERIA, 1970, Project 1314 - Composite Flour. Quart. Progress Rep., Fed. Inst. Ind. Res., Oshodi, Jan. - March pp. 12 and Apr.- June pp 13-18.

- PELISSIER, 1952, Millets et Sorghos, les Blés, la Farine, le Pain. FAO, Cours Nutritionistes Afrique Sud-Sahara, Marseille, 21 Avril-5 Juillet. II Composition des Aliments, CNM/CII/I, 22 pp.

- PERTEN, H., 1969, Etude sur la Fabrication de Pain de Type Français. FAO, AGS:SF/SEN 5, ITA, Sénégal, Rap. d'Expert - conseil I. 51 pp.

- _____, 1969, Study of Making French-Type Bread by Mechanical Dough Development, Mixing Wheat Flour with Cassava Starch and Millet Flours. I.T.A., Senegal, FAO, AGS:SF/SEN 5.

  The study showed the feasibility and potential of making French-type bread from composite flour mixtures of cassava starch, millet or soya bean with wheat flour, using mechanical dough development. The author found the French-type loaves lend themselves to composite flour doughs better than tin bread. If the dough consistency was kept soft, millet and cassava flour could be substituted up to 30% with weak wheats and 40-50% with strong wheat flours. Admixture of glyceryl monostearate and oxydising agents were found less necessary with millet flours than cassava. If chemical dough development is used, millet flour dough will produce only a slightly poorer loaf by the conventional method than by mechanical development. Millet bread was darker than cassava bread, but was generally considered superior. Keeping qualities of both millet and cassava breads proved acceptable. The author recommends continuing trials with different varieties of millet and cassava.

- _____, 1970, Etude sur la Fabrication du Pain de Type Français avec Pétrissage Mécanique et en Diluant de la Farine de Froment avec de l'Amidon de Manioc., FAO, AGS/SF/SEN/64/505, 51 pp.

- _____, 1971, Etude d'Utilisation de Sorgho Camerounais en Panification. Rap. No. 83, 8 pp.

- PERTEN, H., ET AL, 1972, Fabrication de Pain de Type Français avec Incorporation de Farines de Mils et Sorghos. FAO, AGS:SF/SEN 5 Rap. Tech. No. 8, 77 pp.

- PRINGLE, W., WILLIAMS, A. & HULSE, J.H., 1969, Mechanically Developed Doughs from Composite Flours. Cereal Science Today, 14 (3) 114, 16, 18, 20 and 29.

  A standard recipe of 64% wheat flour, 30% cassava starch and 6% defatted soya flour produced a good quality loaf (volume, appearance and eating quality) when made by a modified Chorley-Wood process. Various levels of soya flour, cassava starch and other starch and protein sources were used to make bread and compared against the standard. Among other variations, the replacement of cassava with maize starch produced an almost equal quality loaf with brighter crumb colour. A blend of millet and sorghum flours in place of cassava flour produced a bread similar in colour to light rye bread. A comparison of mechanical dough development, no-time dough mixed in a slow-speed conventional mixer and the bulk fermentation procedure used on the standard recipe showed the mechanical development procedure to produce loaves of better volume, colour and eating quality than the other two methods.

- SEMEDO, J.L. & GUERRA, J.B., 1963, Some Notes on Sorghum: Its Cultivation, Breeding and Baking Tests in Portugal. Melhoramento, 16 pp. 93-109.

  Includes a discussion on the possibility of making bread in which sorghum flour could be mixed with wheat flour and concludes that at present, mixing of sorghum flour at a rate of 10% is acceptable.

- SMEETS, H., 1971, Millet Bread Launched in Chad. Trop. Sci. 13 (3) 215-17.

  Reports that bread containing 40% millet has been sold in Chad since Jan. 1971 at 20 CFA compared with 30 CFA for wheat bread. It is well received and stocks are quickly exhausted. It makes a longer-keeping loaf with better nutritional value.

- TROP. PROD. INST., 1971, Proceedings of a Symposium on the Use of Non-Wheat Flour in Bread and Baked Goods Manufacture. TPI, 27 Nov., 1970, TPI Rep. G62, 33 pp.

- UNIDO, 1971, Bread Before Cakes is Good for National Economy. UNIDO press release, Feature No. 4, 2 pp.

- YOUNGS, A.J., 1972, Wheat Flour and Bread Consumption in West Africa: A Review with Special Reference to Ghana. Trop. Sci. 14 (3) 235-44.

  The consumption pattern for wheat bread in Ghana has an urban/rural and south/north asymmetry; a pattern that has remained similar since the year 1529. Sophisticated wheat milling industries can be found all over West Africa. The baking industry is of an artisanal nature in Nigeria and Ghana while in Senegal and Ivory Coast, baking is quite industrialized. The author feels that the experiments with composite bread flours being conducted in Senegal and Chad have a worthwhile potential.

(iii) New and Modified Uses

- ABBOT, J.C., 1967, The Economics of Food Industries in the Developing Countries. FAO, in: Mon. Bull Agric. Econ. Stat. 16 (3) 1-5.

- ABUSIN, A.M., 1970, Food Processing Research Centre (Shambat) - Research Projects. J. Fd. Sci. Tech. in The Sudan, 2 (1) 47-49.

- ADRIAN, J. ET JACQUOT, R., 1961, De Supplementation d'une Ration à Base de Sorgho et d'Arachide par la Farine de Poisson ou par des Acide Amines Purs. Annales de la Nutrition et de l'Alimentation, 15 (5) 227-37.

- AKINRELE, I.A. & BASSIR, O., 1967, Nigerian Infant Food - Nutritional Value and Preparation. J. Trop. Med. Hyg., 70 (11) 279.

- _____, 1968, New Developments in the Processing of Local Agricultural Products. Proceedings Agric. Soc. Nigeria, 5 pp 16.

- ALGERIA, 1968, The Position of Algerian Agriculture in 1967. Stat. Agric., Alger, 7, pp 1-259.

  Detailed information on the agricultural situation in Algeria in 1967 is presented. Subjects covered include: research and food industries. Agriculture in the Sahara region is dealt with separately in an annex.

- ANGIBAUD, R., 1948, De l'Utilisation de Diverses Plantes Coloniales dans la Fabrication des Pâtés à Papier. Paris, O.R.S.C., No. 4, 79 pp.

- ARIBERT, M. & VIDAL, L., 1924, Essais de Fabrication de Papier avec la Tige du Sorgho du Sénégal. Agron. Coloniale Paris, Nov., pp 171-78.

- ASSELBERGS, E., 1964, Food Preservation in Tropical and Sub-Tropical Countries. Proc. 1st Inter. Cong. for Fd. Ind., Abidjan, pp 353-60.

- AUCAMP, M.C. ET AL, 1961, Kaffircorn Malting and Brewing Studies: VIII. Nutritive Value of Some Kaffircorn Products. J. Sci. Fd. Agric., 12, 449.

- BISMUTH, M. & MENAGE, C., 1961, Les Boissons Alcooliques en AOF (Biere de Petit Mil et Sorgho). Bull. IFAN, (Dakar), 23, series B, (1/2) 60-118.

- BRIANT, L. & HERMAN, H., 1918, Sudan Dura as a Brewing Material. J. Inst. Brew. 15, pp 24.

- BULL. AFR. NOIRE, 1970, African Agriculture, Paris Spec. No. 1, 2 vols., 598 pp.

  The bulletin reviews developments and plans for French-speaking African countries in the area of agriculture (crops, animals, fish, forestry and industrial processing of agricultural products). Countries are dealt with individually: Cameroon, Ivory Coast, Dahomey, Congo-Brazza and Central African Republic in Volume I, and Gabon, Upper Volta, Mali, Mauritania, Niger, Senegal, Chad and Togo in Volume II.

- CAMERON, M. & HOFVANDER, Y., 1970, Feeding Infants and Young Children. P.A.G., FAO/WHO/UNICEF, 18th Meeting, Rome, 1970, 136 pp.

  This manual is a fairly comprehensive review of nutritional information as it relates to feeding infants and young children in developing countries. Included in its 14 chapters is a section on the effects of food processing on the nutrition of the food. The effects of storage, milling, parboiling, refining and fermenting of cereals and legumes, both beneficial and adverse, are briefly reviewed. Another chapter is devoted to a listing of a number of recipes using the various cereals and legumes (among others), normally found in developing countries.

- CEYLON, 1957, Rancidity in Flour from Four Varieties, due to Lipolytic Activity; Inactivation by Heating. Admin. Rep., Dir. Agric., Ceylon, Part IV, 1956, 36 pp.

- CHANDRASEKHARA, M.R. & SWAMINATHAN, M., 1957, The Enzymes of Pearl Millet (Pennisetum typhoideum) Malt: Part I - Amylases. J. Sci. Ind. Res. (India), 16, 35-38.

- CLARET, Y., 1967, Tentatives de Promotion d'Aliments Nouveaux. FAO, No. AT 2396, SF/67/6, 18 pp.

- COETZEE, W.H.K. & PEROLD, I.S., 1958, Precooked and Enriched Cereal Products. S. Afr. J. Agric. Sci. 1 327.

- CONTOR, S.M., 1968, Uganda - Feasibility Study for Establishing a Food Industry Development Centre in Uganda. Rep. to the Gov't., FAO, AGS-UNDP TA 2571, 45 pp.

- DOGGETT, H., 1970, Sorghum. London: Longmans, Green and Co. Ltd., Trop. Agric. Series XVI, 403 pp.

- EAST AFR. AGRIC. FOR. RES. ORG., 1964, Sorghum Tasting and Brewing Trials. Ann. Rep., pp 98-99.

  By far the most popular food was a mixture of sorghum 40%, Eleusine millet 30% and cassava 30%. The mixture was always preferred over any sorghum. Eleusine or Pennisetum millet singly and cassava and maize on their own were strongly rejected. Several varieties of sorghum were preferred to Eleusine, but the "Iteso" peoples claim Eleusine to be their preferred food. The ranking of varieties gave no indication of any preference for white grains with corneous endosperm, nor any rejection of coloured grains or those possessing a brown sub-coat. The preferred colour of "atap" was a mahogany colour. There is evidence that white corneous grains are preferred by people accustomed to eating maize and by sorghum-eating peoples in India, The Sudan and West Africa. Suitability for food or drink often governs the crop or variety grown far more than yield does.

- _____, 1966, Kenya - Plans for Research into Products, etc. Nairobi, pp 633.17.

- EBONG, U.U. & RAGHUNTHAN, K.R., 1970, Acceptability of Varieties, Preparations, Dishes, Drinks. Afr. Soils 15 (1/2/3), 289-300.

- ENIX, J.R., 1963, A Feasibility Study of Grain Storage and Mixed Food Manufacturing in Libya. U.S. AID.

- FAO - Nutrition Div., 1966, Report of the 1st FAO Food Technology Seminar for the African Region, Accra, 37 pp.

- FAO - AGS, 1969, The Role of Rural Processing Industries in the Economic Development of Afro-Asian Countries and FAO's Activities in that Field. AGS-MISC/69/3, 45 pp.

- FAO, 1969, Summary Record of the Joint Meeting of the Sub-Group on Food Processing Industries and Marketing and the Ad Hoc Working Group on Utilisation of Agricultural By-products., Rome, 20 March, IP/AGS/AN-G/69/14, 7 pp.

- FAO, 1969, Utilisation of Agricultural By-products and Surplus Crops in Composite Flours, Rome, 20 March, IP/AGS/AN-G/69/7, 3 pp.

- FAO, 1971, High Priority Needed for Agro-Industries in the Economic Development Plans of Technologically Less-Advanced Countries.

- FURIA, R. di, 1970, Account on the Situation of the Main Food Industries in Senegal. Rep. prepared for the Gov't of Senegal, FAO, AGS:SF/SEN 5, Tech. Rep. No. 4.

  The report reviews the present state and development potential of various food industries in Senegal, including among others: flour milling, bread and biscuit manufacturing, and beer and soft drink industries.

- GRUNDER, M.U., 1968, Etude des Possibilites de Transformation et d'Utilisation Industrielles des Cereales et Legumineuses Locales au Senegal. FAO, AGS:SF/MISC/1, 21 pp. RESTRICTED.

- I.T.A., DAKAR, 1973, Amélioration des Mils. Communication presentée lors du Comité de Gestion du Projet Fed. Sci., 215.05.25.

- INTER. INST. REFRIG., 1965, Refrigeration Techniques in Developing Countries. Publ. TR/2 of the I.I.R., 177 Boulevard Malesherbes, Paris 17E, 116 pp.

- JARDIN, C., 1965, Note on Conversion Factors from Raw to Processed Foods. NU-FAO/ICNND/AFRICA/4, 29 pp.

- KARPER, R.E., 1946, Possibilities for Industrial Uses of Grain Sorghum. The Chemurgic Digest, Reprint No. 40.

- KENYA, 1971, Sorghum Recipes. Home Econ. Dept., Univ. of Nairobi, for the East Afr. Ind. Res. Org.

  This pamphlet contains a compilation of recipes using sorghum flour as a basic ingredient in appetisers, main dishes, deserts, cakes and biscuits.

- MACLAY, W. & DAYTON, 1959, Grain Sorghum Utilisation Research. 1st Grain Sorghum Res. and Util. Conf., 13.

- MERSADIER, Y., 1968, Les Céréales Sénégalais, leur Consommation et leur Transformation Industrielle (Etude Socio-Economique). FAO, SF/SEN/64/505, 39 pp.

- MOALI, P., 1948, Le Sorgho Sucre, Plante Industrielle d'Actualité. La Voix des Colons. (Alger), No. 1462, pp 2.

- MONTAGNAC, H., 1964, Report on the Agricultural Product Processing Industries in North Africa - Algeria, Libya, Morocco, Tunisia. FAO, Econ. Comm. for Afr., 40 pp.

- N'DOYE, T., 1968, Nutrition and Industry., in: Proc. of the West Afr. Conf. on Nutr. and Child Feeding, Dakar, pp 241-45.

- NIGERIA, 1968, Food Manufacturing and Processing Industry. Nig. Trade J., Lagos, 16 (2) 64-72.

  A review of the present food processing position in Nigeria is given. Over 50 of the 150 food processing factories are located in Lagos. Bread bakeries are distributed throughout the country. Discussions on the need for expanding the food processing industry are presented and several areas for consideration are discussed, including: fruit and vegetables, milk, animal and animal by-products, food drinks and baby foods.

- PARPIA, H.A.B., 1967, Overcoming Malnutrition through Food Science and Technology in Developing Countries with Particular Reference to India. Paper presented at the 27th Ann. Meeting of the Inst. of Fd. Tech., USA, Minneapolis, 14-18 May.

- PELSHENKE, P.F., 1960, India - Fundamental and Applied Aspects of Cereal Technology. Rep. to the Gov't. NU-EPTA 1222, 37 pp.

- PERISSE, J. ET AL, 1959, Bilan Nutritif de la Transformation du Sorgho en Bière. Préparation, composition, consommation d'une Bière du Togo. CNRS Ann. Nutrition Aliment., Paris, 13 (1) 1-15.

- PERTEN, H. ET POT, R., 1971, Resultats Préliminaires de l'Etude sur la Fabrication de Farine pour Couscous. UNDP Projet 205 Rap. No. 84, 4 pp.

- POLIAKOFF, J.B., 1969, A General Survey of Food and Food Processing Industries in UAR. FAO, AGS, 127 pp., RESTRICTED.

- PUMAIN, E., 1970, Food Legislation and Quality Control in Senegal. I.T.A., Senegal, AGS-UNDP/SF SEN 5, Tech. Rep. No. 3, 43 pp.

- RAO, J.B., 1967, Informal Technical Report to the Gov't of Sudan on Vegetable Tannin Production. FAO, LA-SF 67/60, 18 pp. RESTRICTED.

- _____, 1968, Informal Technical Report on Tannin Technology and Production. FAO, LA-UNDP/SF 68/34 SUD/2, 27 pp.

- REV. AGRIC. AFRIQUE DU NORD, 1952, Le Sorgho Sucre, Plante Fourragère d'Ete. Alger. Avril, No. 1707, pp. 252-254.

- SEBRELL, W.H., 1967, Amino Acids Supplementation of Cereal Flours - Methodology of Large-Scale Testing. NU-FAO/WHO/UNICEF, PAG 67, 8 pp.

- SENEGAL, 1961, Une Alimentation Saine et Abondant Grâce à ... La Farine "21" - Mil - Arachide., 89 pp.

- SENTI, F.R., 1965, The Industrial Utilisation of Cereal Grains. Cereal Sci. Today, 10 320-27, 361-62.

- _____, COPLEY, M.J. & PENCE, J.W., 1967, Protein - Fortified Grain Products for World Uses. Cereal Sci. Today, 12, 426, 428-30, 441.

- _____, 1968, Formulated Cereal Foods in the U.S. Food for Peace Programme. Presented at the Joint AACC-AOCS Meeting, Wash., D.C.

- SIMBA, I., 1962, Improved Village and Household Conservation of Food. In: Draft Rep. on the Nutr. Semin. for Ethiopia, Kenya, Somali, Tanganyika, Uganda and Zanzibar. Tanganyika, 4-28 Aug., pp 57-59.

- SUBRAHMANYAN, V. ET AL, 1950, Investigations on the Preparation, Properties and Nutritive Value of Rice Substitutes from Tubers and Millets. J. Sco. Ind. Res., 9B (10) 259-61.

- SUNDARARAJAN, A.R., 1969, Development and Activities of the Food Chemistry Unit, Food Res. and Dev. Unit, Ghana. NU - UNDP/SF GHA/7 38 pp., RESTRICTED.

- SURE, B., 1957, The Addition of Small Amounts of Defatted Fish Flour to Whole Yellow Corn, Whole Wheat, Whole and Milled Rye, Grain Sorghum and Millet. J. Nutr., Philadelphia, 63 (3) 409-16

- SWANSON, A.F., 1949, Starch - a New Outlet for Sorghum Grain. Kansas State Board Agric. 48 (292) pp 1.

- U.N.D.P., 1972, Production of Panels from Agricultural Residues; Report of the Expert Working Group Meeting, Vienna, 14-18 Dec., UNDP Org. 1970, 5, 37 pp.

  The report begins with an outline of past research into panel production from agricultural residues and non-wood fibrous materials. The other subjects discussed were: techniques and economics of harvesting and pre-processing agricultural residues, production techniques for different panels, marketing of panels, adhesives for use in panel production, the need and proper role of standards and quality control in developing new products. Twelve recommendations are made.

- U.S., 1971, Improving Nutritional Value of Cereal Based Foods. Kansas State Univ., Manhattan, Kansas.

- VRIES, E. de, 1971, Nutritive and Food Value of the National Food of the Chad Republic. Bull. Seanc. Acad. Royale Sci. Outre-Mer, 4, 810-22.

  This article describes the development of some new foodstuffs with high nutritive and food values and good storage characteristics in the Chad Republic. One such food product is made through a simultaneous valorisation of fresh fishmeat and a starchy product, such as sorghum or yam flour. All materials are available regionally.

- WALL, J.S., & ROSS, W.M., (ed), 1970, Sorghum Production and Utilisation. Westport, Conn.: AVI, 702 pp.

  This book is the first comprehensive work on sorghum as a major world crop. Individual chapters deal with the history, distribution and varietal types of sorghum, plant structure, genetic variability, breeding and chemical composition. The second section deals with production including special varieties for forage and syrup. The last section deals with the utilisation of sorghum grain. Chapter 16 is devoted to the dry milling, products and uses of sorghum grain common in Western countries.

- WATSON, S., 1955, Peripheral Cells of the Endosperm of Grain Sorghum and Corn and their Influence on Starch Purification. Cereal Chem. 32 (3) 165-82.

- WILKIE, N.A., 1968, The Role of Promotion in Marketing Low-Cost, High-Protein Foods. Nutrition Newsletter, 6 (4) 30-33.

- ZWANKHUIZEN, M.T., 1963, Report of the West African Mission on Transport, Trade and Industry to Chad, Dahomey, Ghana, Guinea, Ivory Coast, Liberia, Nigeria, Senegal, Sierra Leone, Togo. FAO, 32 pp.

- _____, 1967, Improved Processing, Handling, Storage and Utilisation of Agricultural Products and the Role of Agriculture in the Build-Up of Industrial Development. FAO, National Training Centre on Agricultural Marketing, Uganda, 22 pp.

(iv) Packaging

- FAO/WHO, 1968, Packaging Material, Programme Liaison Div., PI-ALINORN 68/29, 8 pp.

- HEISS, R., (ed), 1968, A Guide for Food Packaging for Developing Countries. NU-MISC/68, draft, RESTRICTED.

- JONES, A., 1968, Plastics, Packaging and Tropical Countries. Rubber and Plastics Age, 49 (4) 322-23.

- PAINE, F.A., 1967, Packaging Materials and Containers. Blackie and Sons Ltd., London and Glasgow.

- WALLENBERG, E., 1967, Food Packaging in Ghana. Ghana Fd. Res. and Dev. Unit., FAO, UNDP/SF Projet, NU-SF/67/6, 50 pp. - comments and recommendations.

3. Animal Feeds

- ALDER, F.E., 1969, Better Utilisation of Feeds of Industrial By-Products. AN-AFA/69/3, 3 pp.

- BAKER, G.N., ET AL, 1958, Methods of Feeding Sorghum to Fattening Steers. Nebraska Agric. Expt. Stn. B., No. 451, 8 pp.

- EAST AFR. HIGH COMMISSION, 1956, Milling and Offals for Livestock. Some notes on Ind. Dev. in East Afr., pp. 41.

- FAO/Industrial Co-operative Programme, 1968, Agricultural By-Products as Animal Feeds - A Possible Sphere for FAO - Industrial Co-operation. IP-MISC/68, 4 pp.

- FAO, 1971, Survey of Export Markets for Sorghum. Commodity Bull. Ser. 49.

  Discusses mainly the role of sorghum as a livestock feed in international markets.

- FRENCH, M.H., 1948, Local Millets as Substitutes for Maize in the Feeding of Domestic Animals. The East Afr. Agric. J., Nairobi, pp 217-220.

- _____, 1973, High Moisture Ensiling of Sorgho Grain. 3. Disappearance of Carbohydrates and Production of Organic Acids and Ethanol. Cuban J. Agric. Sci., 7 (2), 207-212.

- HARDY, C., 1973, Amylases in the High Moisture Ensiled Grain of Sorgho, Cuban J. Agric. Sci., 7 (2), 213-217.

- JOBLIN, A.D.H., 1966, The Response of Teso Zebu Milking Stock to Moderate Levels of Supplementary Feeding. Afr. Agric. For. J., 31 (4) 368.

- JOHNSTON, B.J. & HARRIS, H.B., 1967, Silage Products of Sorghum, Soybean, and Sorghum - Soy Mixtures. Sorghum Newsletter, (10), 22.

- KUNKEL, H.O., 1959, The Value of Grain Sorghums in Livestock Rations. Feed Illus., 10 (5) 54-57.

- LOEFFEL, W.J., 1957, Grain Sorghums as Feeds for Beef Cattle and Hogs. Nebraska Agric. Expt. Stn., Lincoln, Na., 35 pp.

- MILLER, T.B., RAINS, A.B., & THORPE, R.J., 1964, The Nutritive Value and Agronomic Aspects of Some Fodders in Northern Nigeria. III. Hay and Dried Crop Residues. J. Br. Grassld. Soc. 19 77-80.

- MORRIS, J.G., 1958, Drought Feeding Studies with Cattle and Sheep. Queensland J. Agric. Sci., Brisbane, 15 (4) 161-213.

- ONLEY, J.A., 1960, Grain Sorghum Tops Off Bullocks in Dry Spring. Queensland Agric. J., Brisbane, 86 (3) 145-48.

- PALMER-JONES, R. and HALLIDAY, D., 1971, The Small-Scale Manufacture of Compound Animal Feed. TPI, G67, 56 pp.

  The report is a general guide on the possibilities of compound animal feed mills, but based in part on data from an enterprise in a developing country in Asia. It attempts to deal with all the main factors involved in setting up a feed milling industry with a capacity of from 1-10 tons per hour. Chapters are devoted to nutritional principles, raw materials and their composition and potential for animal feeds (includes: sorghum, millets, maize, pulses and teff), an outline of the manufacturing process, cost models and the economics of small-scale production. Appendices include: feed composition tables, schematic diagrams of an impact grinder and four models of compound feed mills, with detailed capital and operating cost, floor space, power, raw material and manpower requirements of each of the four models of mills.

- PFOST, H., 1971, Observations and Recommendations for Construction of Feed Mills in Senegal, Mali and Mauritania. Kansas State Univ., AID/csd - 1588, 12 pp.

  This report evaluates the plans for feed mills to be constructed in Senegal, Mali, and Mauritania. The three nations are co-operating on a broiler production project which will require feed mills and grain storage. Because of the shortage of grains generally, feed was consisting mostly of imported sorghum and rice hulls. Comments are made on the design, equipment, construction, maintenance, and operation of the feed mills.

- RAAY, J.G.T. van & LEEUW, P.N. de, 1970, The Importance of Crop Residues as Fodder. A Resource Analysis in Katsina Province, Nigeria. J. Econ. Soc. Geo. 61 (3) 137-47.

  The authors discuss the volume of crop residues, their value as fodder and the relationship of crop residues to the livestock industry in North Central Nigeria. They conclude that the quantity and quality of millet, sorghum, cotton, groundnut, cowpea and cassava residues are sufficient to sustain the present volume of livestock from October to February. They also feel that the availability of crop residue fodder over this period is sufficient to carry most herds over until the rains bring on pasture again.

- ROBERTSON, E.I., 1965, Report to the Gov't of Libya on Animal Feeds. EPTA Rep., FAO, No. 1938.

  This report deals with the need for an animal feed industry to improve Libya's livestock supply. Specifically, it assesses the present situation, and projects future needs, including: an estimate of the quantity of feed required, the use of local agricultural waste materials as feed and advice on technical nutritional problems in the operation of a feed-mixing plant.

- SCOTT, K.W., NOLAND, P.R. & McNEAL, 1961, Using Milo in Swine Rations. Arkansas Farm Res., Fayetteville, 10 (5) 11.

- THORPE, R.J., 1964, Cereal - Legume Silage Mixtures for the Northern Guinea Zone, Nigeria. Trop. Agric. 41 (1) 41-45.

- VAVICH, M.G., 1959, Nutritive Value of Low and High-protein Sorghum Grains for Growing Chickens. Poultry Sci., Ithaca, N.Y. 38 (1) 36-40.

H. Extension and Training Aspects to Post-Harvest Technology

- BUNTJER, B.J., 1972, Who to Blame: the Farmer or the Extension Worker? Samaru Newsletter, 14 (1) 8-13.

  This article examines the communication processes and links between farmers and extension workers, in Northern Nigeria, primarily. The author feels that lack of communication between farmers and extension workers is often due to the extension workers' lack of knowledge about farmers' experiences and about what new ideas a farmer should be learning. Recommendations are made for improving the communication links.

- CAH. AGRIC. PRAT. PAYS CHAUD, 1965, The Link Between Research and Extension on the Structural Level. No. 3, pp 169-72.

  Report on the attempt of Madagascar and Dahomey to supply a structure whereby research and extension can work together for agricultural improvement. The system involves a set of experimental stations, trial fields and field trials on farmers' land, all established on a regional basis. The researchers instruct the extension workers on techniques they have developed and they work together on improving extension methods and discussing experimental techniques and results.

- DESARROLLO RUR. AMER., 1970, Study of the Organisation and Functioning of an Agricultural Extension System Geared to Accelerated Increase of Production. 11 (2) 109-123.

  A description is presented of SATEC, a decentralised organisation financed by the French Gov't and the European Development Fund. It provides technical assistance in agriculture, mainly in the French-speaking countries of Africa. A contract with the Gov't of Senegal to raise the productivity in groundnuts and sorghum by providing technical assistance to farmers through organisation of an extension service and supplying credit for equipment and fertilisers, is described as an example to illustrate how SATEC works. Special attention is paid to the training of bottom level field personnel.

- ECA/FAO, 1971, A Comparative Analysis of Agricultural Extension Systems of Eight East-African Countries - with Suggested Guidelines for Improvement. ECA/FAO Joint Agric. Div., E/CN 14/AGRIP/10, IV.

  The study reviews the organisation and administration of agricultural extension services in Ethiopia, Kenya, Madagascar, Malawi, Somalia, Tanzania, Uganda, and Zambia. It compares each extension service as to its importance to the country, its organisation and the methods used. Remarks on the availability of research findings, special extension programmes and discussions of factors limiting extension work are included. The last section deals with recommendations for improvement.

- FAO/AGS, 1966, Report on the Short-Term Course in Infestation Control in Raw and Processed Foods. AGS-FFHC/India 9, FFHC Rep. No. 48, 20 pp.

- FAO, 1968, Report of an FAO Ad Hoc Consultation on Programme Development in Home Economics in Africa, Ghana, 1968, Rome.

- FAO, CANADA-PLUS-ONE, 1968, Report to the Gov't of Ghana, National Training Course in Grain Storage and Infestation Control. Rep. No. PL:CP/24.

  The appendix to this report contains the programme of the course. Subjects covered were: insect biology and identification of pests, grain storage principles, marketing boards, types of storage loss, insect control (dusts and different fumigants) and Ghana stored products legislation.

- FAO, 1968, Report to the Gov't of Ghana, National Training Course in Grain Storage and Infestation Control, Accra, 30 Sept. - 25 Oct., FFHC, No. 36.

- FAO, 1969, Lecture Notes of Training Course on Grain Storage in Dakar, 20 Oct. - 14 Nov., UN/FAO with Inst. Tech. Alimen., UNDP.

  The course covered: prevention and control of insects in produce, types of losses in stored products and their cause, principles of good grain storage, chemical control, review of some storage trials in Senegal, along with other topics relevant to storing grain.

- FAO, 1969, Report on the Short-Term Course in Flour Milling and Baking Technology, Mysore, India. AGS-FFHC(India)9, FFHC Rep. No. 56, 27 pp.

- FAO, 1970, Rapport au Gouvernement du Sénégal sur Deux Cours de Formation en Matière de Stockage des Céréales et de Desinsectisation. Campagne Mondial Contre la Faim. FAO, 61, 9 pp.

  Gives addresses by honoured guests and outline of lectures given during the course.

- FARCY, H. de, 1964, Rapport de Mission sur les Problèmes de la Formation du Personnel Chargé de la Commercialisation des Produits Agricoles dans les Different Pays d'Afrique d'Expression Francaise; Cameroun, Côte d'Ivoire, Sénégal, Tchad., FAO.

- FORBES, A.P.S., 1962, Relations between Extension and Research Services. In: Dept. Tech. Co-op., Misc. 2, London, HMSO, pp 74, 75.

  The article discusses the co-operative relationship developed between the researcher and extension worker in Tanganyika, even though the two disciplines remain formally distinct.

- GAUDY, M., 1969, Animation Rurale, Extension and Means of Economic and Social Development in Tropical Countries. Paris, La Maison Rustique, Libraire Agricole, Horticole, Forestiere et Menagere, VII, 133 pp.

  This publication is a manual on the methods of agricultural development, principally in French-speaking African countries. The first part of the book deals with methods of gathering agricultural data and of planning. Part II gives discussions on: agricultural extension, all types of training (farmer, vocational, technical, and professional), research, rural advisory services, co-operatives, credit and other means of financing agricultural development.

- GHANA, 1972, Development and Dissemination of Appropriate Technologies in Rural Areas. Univ. of Sci. and Tech., Kumasi, Ghana.

- HALLARD, J.N., 1968, Integrated Development in Northern Togo (1967-68). Agron. Trop. 24 (5) 463-504.

  A description of the development procedures in the north of Togo is presented. The area is characterised by a long dry season, high density population and subsistence agriculture based on sorghum and millet. Some of the development projects described include, animal powered cultivation, construction of roads and building of warehouses. A problem remains in the availability of adequately trained staff.

- KENYA, undated, Handbook for Produce Inspectors in the Central Province. Central Province Marketing Board.

- LOUWES, H.J., 1968, The Role of Agricultural Credit. National Training Centre on Agricultural Marketing, Libya, Lecture No. 16, pp 114-21.

- MARCOMER, Etude d'une Compagne de Vulgarisation de Masse pour l'Amellioration des Techniques Cultures de l'Agriculture Nigerienne.

- ONAZI, O.C., 1973, The Development of Agricultural Extension in Northern Nigeria. Samaru Agric. Newsletter 15 (2) 52-55.

- ORGANISATION INTERNATIONALE DU TRAVAIL, 1972, The Training of Instructors and Extension Agents for Agricultural Development by and under the Control of the Agriculture Training Centres. Geneve, Rapport Technique 2, VIII, 31 pp.

  The report discusses the effectiveness of a Gov't of Mali and Inter. Labour Org. joint project on agricultural training, started in 1965. To-date, the project has dealt with: assessing the needs of agricultural development organisation for extension agents, re-establishing three existing training centres and training ILO counterpart staff, instructors for the centres and extension agents. Recommendations include expanding the three existing centres and initiating a fourth.

- PARPIA, H.A.B., ET AL, 1971, Short-Term Course in Infestation Control in Raw and Processed Foods, Mysore, India, FAO, DANIDA, FAO 68, AGS:FFHC/INDIA 9.

  This brief report sets out the origin and organisation of the FAO International Food Technology Training Centre at Mysore, India. The agenda and outline of a short-term course on infestation control in raw and processed foods is presented. Subjects covered in the course include: Insects, rodents and other pests of stored products, their identification and effect on stored products, insecticides and fumigants and techniques of application, grain and oil milling techniques and fumigation of flour mills, fumigation equipment and other methods of pest control.

- _____, 1973, Problems of Technology Transfer in Food and Agricultural Industries in Developing Countries.

- U.S., 1971, Report of the Joint USA/Ghana Committee on Agricultural Extension and Research. U.S. Academy of Science and Univ. of Ghana Council for Science and Industrial Res., Oct., 55 pp.

- VERCRUIJSSE, E.V.W. & BOYD, T.A., 1970, Evaluation of an Extension Programme: Report of a Pilot Study into the Effects of the Focus and Concentrate Programme in the Tamole Area. Res. Rep. Series Paper, Soc. Stud. Proj., Univ. Coll. of Cape Coast, Cape Coast, No. 4, 71 pp.

  An attempt is made to evaluate the effect of the Focus and Concentrate farmer extension programme in Ghana. Twelve farmers who had been under the programme and 12 who had not, were surveyed on a number of subject areas such as: what percentage of their crops were sold, number of labourer-working days for harvesting and other operations, amount of food purchased and other questions as to use of services and improved farming techniques and their answers compared.

- WATTS, E.R., 1969, Agricultural Extension in Embu District of Kenya. East Afr. J. Rur. Dev. 2 (1) 63-77.

  This article reviews some of the results from a survey of Embu District of Kenya. It describes the structure and functioning and gives an indication of the effectiveness of farmer-level agricultural extension work. Conclusions are drawn and listed under three headings: General, Extension Staff and Communications.

- WILLIAMS, S.K.T., 1969, Sources of Information on Improved Farming Practices in Some Selected Areas of Western Nigeria. Bull. Rur. Econ. Soc., Ibadan, 4 (1) 30-51.

  A random survey of 395 farmers showed that 81% had indicated acquiring knowledge of new farming practices, while 19% had not. Most farmers indicated making use of agricultural extension officers (which constituted 32% of all sources of information), 29% of the information was acquired from radio and 15% of the people received their information from neighbours. Information is also given on individual farm practices in cotton and rice production and the farmers' knowledge of improved techniques.

- YOUNG, M. de, ET AL, 1971, Courses in Co-operative Management and Agricultural Marketing, Vol. I. Subjects for Common Study., Vol. II. Specialised Subjects. pp. 327 and 332.

  The publication contains lecture notes and discussions resulting from a three-month course at the Panafrican Co-operative Training Centre in Cotonou. The general course covered: accounting, commerce, statistics, management, law and psychology as they relate to the rural areas and co-operatives. The specialised courses covered co-operative management and agricultural products marketing.

III. MAIZE

A. Post-Harvest Systems

- ADENDE, A., 1953, Maize Harvesting and Utilisation and Storage. Bull. de l'Inst. Français d'Afrique Noir, 15 (1) 220-82.

- FAO/UNDP, 1973, Maize, Preliminary Commodity Note, Background to the third Five-Year Plan. Marketing Dev. Bureau, FAO/UNDP Project SF TAN 27. Min. of Agric., Tanzania, 20 pp.

- FAO/UNDP, 1974, A Strategic Grain Reserve Programme for Tanzania, Vol. II, Background Information (Annexes)., Marketing Development Bureau, Min. of Agric., Dar Es Salaam, FAO/UNDP Project SF TAN 27, 63 pp.

- GHANA, 1963, Maize Storage, Marketing and Utilisation. Ghana Farmer 7 (4) 146-53.

- HEYER, J., 1967, The Economics of Small-Scale Farming in Lowland Machakos. Inst. Dev. Studies, Nairobi, Occasional Paper No. 1, 82 pp.

- KENYA, 1958, The Maize Industry. Sessional Paper No. 6 of 1957-58. Colony and Protectorate of Kenya.

- LEPIGRE, A. & LEFEBURE, H., 1961, Problèmes de Conservation et de Commercialisation du Mais au Togo et Rapport sur la Mission affectuée au Nigeria, au Dahomey et au Togo. IRAT, 145 pp.

  The report reviews the existing grain storage practices in the three countries, including traditional and improved methods. Recommendations are made on storage and extension techniques. The second section outlines the costs of extension training and research into fumigation techniques and the last section deals with the commercialisation of the maize industry in each of the three countries. This includes discussions of the market and price situations and changes necessary there, and the organisation of co-operatives and marketing boards.

- MATHEWS, V.G., 1963, Conclusions of an Enquiry into the Maize Industry in Kenya. Kenya Farmer, No. 83.

- MIRACLE, M.P., 1958, Maize in Tropical African Agriculture. Trop. Agric.

- _____, 1966, Maize in Tropical Africa. Univ. Wisconsin Press, XVII, 327 pp.

- NYARCO, S. & APPIAH, D., 1968, Report on Maize Farm Storage and Marketing Survey, Ghana, 1966/68. RESTRICTED, working copy.

- SHARMA, A.C., 1974, Economy of Ujamaa and Individual Shambas in Iringa Region. Dept. of Rural Economy & Extension, Fac. of Agric., U. of Dar Es Salaam

- deVRIES, J. & FORTMANN, L., 1974, A Study of Ujamaa Villages in Iringa Region, UNDP/FAO. Fac. of Agric., U. of Dar Es Salaam,

B. Harvesting and Conditioning

1. Traditional

- ADESUYI, S.A., 1968, A Survey of the Moisture Content of Early Maize During Harvest in the Western State. NSPRI, Tech. Rep. No. 7, pp 59-61.

  A discussion is presented of the normal maize harvesting practices of farmers in Southern Nigeria. Often, two maize crops per year are attempted and therefore, the first is harvested quite early. Because this early harvest occurs necessarily during the rainy season, moisture content of the grain is usually high. Samples of maize were taken from various farmers' fields in different locations over the month of August, and tested for moisture content. Most samples were found to have between 22 and 25% moisture. It is reported that local maize varieties have a lower moisture retention than other varieties at harvest. Most farmers harvest their early maize green, eating some and selling the rest for immediate consumption. Few farmers attempt storing maize for any length of time due to a fear of deterioration and the poor marketing system.

- AFFUL, E.N., 1962, Production Costs for Maize (Asesewa Case Study). In: Ghanaian Bull. Agric. Econ., 2 (2) 19-23.

  Costs are calculated for many aspects of maize production, including among others: harvesting, hired labour, seed and depreciation of materials used.

- BERGER, J., 1962, Maize Production and the Maturing of Maize, Geneva.

- BURTON, R.F., 1863, Abeokuta and The Camaroons Mountains, Vol. I, London.

- CHAMBON, R. and ALOFS, M., 1958, Le District Agricole du Tanganyika. Belgium, Ministère des Colonies, Brussels.

- CHEVALIER, A., 1910, La Culture du Mais en Afrique Occidentale et Especialement au Dahomey. J. Agric. Trop., Aug.

- HUNTER, T. & DANSO, T.V., 1930, Notes on Food Farming in Ejura, in: Gold Coast, Dept. Agric. Year Book, Accra, n.d.

2. Improved

- A'BROOK, J., 1964, A Cheap Crop Dryer for the Farmer. Trop. Stor. Prod. Info. (7) 257-268 and (8) 301-307.

- _____, 1965, A Cheap Crop Dryer for the Farmer. Samaru Misc. Paper No. 6, IAR, Nigeria, 9 pp.

- ALLAN, A.Y., 1967, Combine Harvesting and Bulk Storage of Maize. Kenya Farmer, No. 127, pp 22.

  The article describes installation on a farm at Kitale, Kenya, of a combine harvester for 800 acres of maize. The combined maize is dried in store.

- ALLAN, A.T., 1967, Drying Maize - Traditional and Artificial. Kenya Farmer, No. 127, pp 23.

- CHANCELLOR, W.J., 1968, A Simple Grain Dryer Using Conducted Heat. FAO, LA-IRC/AE/68/7/23, 4 pp.

- GHANA, 1963, The Maize Industry of Ghana. The Ghana Farmer 7 (4) 146-53.

  The article outlines several operations in the system of marketing, including unhusking ears, shelling and drying. All operations, except for the occasional mechanised shelling and drying operations, are done by hand in Ghana. Machine shelling is done at a cost of 2s6d/bag of 200-220 lbs. Drying is done by a mobile "Nu-Way" dryer at a cost of 1s6d/bag.

- HABIB, M.M., ET AL, 1971, Yield and Quality of Corn Grain and Stover as Affected by Early Harvest and Fertiliser Levels. Alexandria J. Agric. Res. 19 (2), 245-51.

  This study was done in Egypt to determine the effect of various harvesting dates (80-120 days) for maize, in conjunction with nitrogen fertiliser at 102.5 and 153.75 kg/ha singly or with 40 kg P_2O_5/ha. Harvesting at 100 days seemed to give the optimum grain-stover ratio with

no chemical change from normal in grain and only an increase in carotene and decrease in crude fibre in the stover. Effects of the various fertiliser combinations are also discussed.

- HALL, M., 1968, Mechanisation in East African Agriculture. In: Agricultural Planning in East Africa, Helleiner, G.K. (ed), East Afr. Publ. House, Nairobi, pp 81-115.

  This paper examines the potential benefits from, and constraints to, mechanising agriculture in East Africa. The present state of mechanisation is reviewed and examples of mechanisation projects (primarily in Uganda, Tanzania and Kenya) are analysed to illustrate some of the problems encountered with mechanisation schemes. Because harvesting machinery is often so specialised and only of use for the one operation, mechanisation in this area has been slow to develop. However, mechanical harvesting of wheat and maize has been carried out successfully on some large-scale farms in Kenya and Tanzania, but doubt is expressed as to its economic feasibility. With ox-drawn reapers, binders and threshers (a form of intermediate technology), it is not certain that the time and energy and skill required to organise and teach the large crews would save more in the long run than combine harvesters.

- HEARLE, H.F. & HALL, D.W., 1962, The Use of Low-Temperature/ High Air Volume Drying of Tropical Crops. Trop. Stor. Prod. Info., (5) 168-73.

- HUTCHINSON, M.T., 1970, Control of Sitophilus Zeamais in Stored Maize by Using a Modified Mud-Block Dryer. Nig. Ent., May, 2 (2) 56-58.

  Describes the use of mud-block, beehive-shaped dryer that produces enough heat to kill all stages of Sitophilus zeamais and any other insect pests. In all, the moisture content of the maize was lowered from 23.4% to 11.1% over 24 hours. The maize was then stored in plastic sacks for 10 months without infestation. The article also describes results of a second dryer with 50% greater capacity, i.e. 1.5 cwt.

- _____, 1971, A Modified Maize Dryer for the Small Farmer. Nig. Agric. J., 8 (1) 20-35.

  A description is given of a cone-shaped, mud-block dryer, using old tar drum as the fire box, corrugated iron, rolled to make a chimney, and a wood, bamboo slat, chickenwire, drying floor. Cost and profit figures are noted. Discussions of storage trials following drying, using plastic bags and clay pots with various coverings in a mud brick room (to duplicate as closely as possible typical farmer storage conditions) are given.

- JONES, M.E., 1973, Threshing Maize. Rhodesian Agric. J. 70 (2) 49.

  Deals primarily with mechanical shelling of maize. The main factors in preventing grain damage during shelling are: moisture content, (optimum is 15-20%), drum speed, drum clearance, sufficient material to give a cushioning effect.

- KENYA, 1971, Grain Storage and Drying. Kenya Farmer, No. 185, pp 14.

  Brief article explaining for farmers the reasons for using drying apparatus and for ventilating stored grain. It includes: the working of a ventilated storage silo, of a dryer, the length of time taken to dry grain and criteria for assessing when the grain is storable.

- MACHINISME AGRICOLE TROPICALE, 1970, No. 29, pp. 49.

  A simple grain drying apparatus has been tested in Dahomey by IRAT. On an area of 7 square metres, it can lower the humidity of 600 kg of maize from 20% to 14.5%. The air temperature never rises above 55°C during the 10 hours of the operation. The fuel consumption is approximately 60 kg of wood.

- McLEAN, K., 1972, Principles of Sun Drying with Special Reference to a See-Saw Dryer, Ghana. FAO, AGS-UNDP/ SF GHA/7, 44 pp.

- OJURONGBE, E.O., 1965, Low-Cost Bush Crop Dryers and Grain Storage Silo, Nigeria.

  Instructions are given on how to build and use a simple crop dryer and grain silo.

- PETERSON, W., 1969, A Low-Cost Grain Dryer for Tropical Climates. Peace Corps Tech. Notes, 6 pp.

  Detailed instructions for building a cheap grain dryer are given. The basic design is a fire box of three end-to-end oil drums, set in a pit with cement or mud-block walls and chimney. Logs and chicken wire mesh form a platform halfway up the wall on which the grain is placed. The platform is approximately 7' x 7'. Notes on using the dryer are presented, and suggestions for storage of the dried grain made.

- PRASAD, J. and GUPTA, C.P., 1975, Mechanical Properties of Maize Stalk as Related to Harvesting. J. Agric. Eng. Res. 20 (1), 79-87.

- THOMSON, A.G., 1954, Grain Drying in Tropical Countries. World Crops, 6 (4) 144.

  The article discusses the general scope and feasibility of grain drying in the tropics and sub-tropics. It describes a number of methods and machines for artificially drying grain, particularly maize and rice. The report concludes with a discussion of the risk of reabsorption of moisture and alternatives to grain dryers, i.e., bin drying.

- U.K., 1950, The Possibility of Future Mechanical Maize Harvesting in East Africa and Central Africa. Colonial Res. Publ. No. 5, pp. 5.

- U.K., 1956, Mechanical Harvesting - Tanzania. Overseas Food Corporation, H. of C. Paper, No. 195,pp 69-71 and 134-36.

- WEBB, E.R., 1969, A Crop Dryer and Grain Storage Silo for the Small Farm. USAID, Min. Agric. Nat. Resour., Ibadan, Nigeria. 31 pp.

  This booklet, written for the extension worker and farmer, gives detailed instructions and diagrams for building and using a fairly simple and cheap grain dryer and storage silo for maize. The dryer consists chiefly of a firebox made from three end-to-end oil drums set in a pit, walls and chimney of cement blocks, five feet high, and a bamboo mat or chicken wire mesh, 6' x 8', set two feet up the wall as a drying rack. The silo is of cement-plastered, mud blocks, cylindrical, five feet in diametre and six feet high. The top is domed and sealed by the end of an oil drum, mud and plaster.

C. General and Farm Storage

1. Traditional

- CHAMBERS, P.C., MOON, J.T. & GRIEVE, M.H., 1939, Native Methods of Food Storage. East Afr. AGric. J. 5 pp 99-103.

  In some areas, maize is stored on the cob in small round stores, usually raised about two feet from the ground. The sheaths are often removed from the cobs, which then are tied to poles in the open or hung on trees. A few cobs for seed may be hung in the roof of huts where smoke prevents insect damage. Observations were made in Kenya.

- CHUNG, D.S., 1975, Review and Recommendations for On-Farm Grain Storage in Tanzania for Min. of Agric., Tanzania and USAID. AID/ta-C-1162, 34 pp and app.

- DAHNIYA, M.T. & FUNNAH, S.M., 1973, Increasing Maize Production in Sierra Leone. Sierra Leone Agric. J. 2 (1) pp 45-53.

  The article states that the development of the livestock industry in Sierra Leone is increasing the demand for maize. Maize production is discussed along with difficulties likely to arise. One section is devoted to harvesting and storage. It is recommended that artificial drying be instituted, possibly the "Samaru Dryer." Metal silos and oil drums are recommended over the use of bags for storage.

- FORSYTH, J., 1962, Major Food Storage Problems. Agric. and land use in Ghana. Oxford Univ. Press, pp 395-96.

  Traditional harvesting dates and methods and storage methods are described. Moisture content is reduced by sun drying to about 12% in the northern region. Chief storage pests are listed. He notes that no detailed storage work on these pests has been done, but recommends a gamma BHC dust treatment for threshed and unthreshed grain.

- FORSYTH, J., 1962, The Use of Grain Protectant by Ghanaian Farmers. CCTA/FAO Symposium on stored food, Freetown.

- GHANA FARMER, 1963, The Maize Industry of Ghana 7 (4), pp 146-53.

  Traditional maize storage practices are described, construction details outlined for the structure and capacities given. Traditional methods of controlling infestation, levels of insect damage and moisture contents from maize harvested at various times of the year are also given.

- GIBERILA, J., 1969, Protein Composition of African Maize. D'agric. trop. bot. appl. 16 (9-10), pp 383-417.

  General comments on methods of storage and local storage practices.

- GILES, P.H., 1964, The Storage of Cereals by Farmers in Northern Nigeria. Trop. Agric. 41 (3) pp 199-212.

  A description of traditional maize cultivation is given. The early crop is harvested in June to August and late maize in December and January. The maize cobs are harvested, dried where possible and stored with the husks on. Because early maize is harvested during the rains, drying is often difficult. A description of the types of granaries used is given, including dried earth, plant material, underground and pot storage. Maize is rarely stored longer than 9 months; however, actual length of storage will depend on whether the maize is to be sold or used as food.

- GILMAN, G.A., 1970, A Survey of Roof Drying and Storage Practices in the Murango District of Kenya, with special reference to deterioration by fungi. TPI Rep. No. R96.

- MARO, M.A.M. & MPHURU, A.N., 1975, Grain Storage Structures in Tanzania with Particular Reference to Iringa and Morogoro Regions. TSP Info.

- MPHURU, A.N., ET AL., 1974, Traditional Storage of Food Grains in Tanzania (With Special Reference to Storage of Maize in Iringa and Morogoro Regions). Fac. of Agric., U. of Dar Es Salaam, Research Paper.

- MPHURU, A.N., Faculty of Agriculture; Second Conference on Land Use in Tanzania. Paper No. 13/2 - A Review of Storage Problems.

- PATTINSON, I., 1970, La Lutte Contre le Gaspillage Emmogasirage du Grain dans les Villages. FAO, 4452, Campagne Mondiale Contre La Faim.

  This is a short pictorial bulletin, presented in French, dealing with the problem of grain waste at the village level due to insect and rodent damage of stored products in Tanzania. Traditional storage methods are reviewed briefly and a discussion of a pilot scheme to improve farm storage using 45-gallon drums is given.

- RILEY, J., 1961, Maize Storage in Western Nigeria. CCTA/FAO Symposium on Stored Food, 8 pp.

2. Storage Losses

- DOKU, E.V., 1969, Problems of Maize Production in Ghana. The Ghana Farmer 13 (2) pp 61.

  An estimated two-thirds of the harvested maize is lost in storage, mainly through weevil damage.

- RAWNSLEY, J., 1967, Post-Harvest Food Losses in Ghana from Proc. First Seminar on Fd. Sci. and Tech. in Ghana. Fd. Res. Inst., Accra, p. 55-62, May 22-23.

- RAWNSLEY, J.,1970, The Preservation of Maize in Ghana. Ghana Academy of Sci. 1970 Crop Res. Inst. Ann. Rep. 1966, pp 19.

  States that in previous work it was learned that approximately 35% of the harvest is lost through insect damage in the first six months of traditional storage. Experiments were established to assess where and when the worst damage occurred. Plans were developed for extension programmes to popularize chemical fumigation of maize, using ethylene dibromide and plastic bags.

- WHEATLEY, P.E., 1973, The Maize Storage Problem in Less-Developed Countries of Africa - Ghana. Post-Harvest Deterioration. Chemistry Ind. 22 pp 1049-1052.

3. Factors Affecting Storage

(i) Biological

- ASHMAN, F., 4/12/64, Trop. Stor. Prod. Cen. File C-1/3/1.

  Density of population of insects in bags of maize and other produce are listed. The author would anticipate a peak population level of about 2-400 Cadra cantella larvae. The peak appeared to occur very early after fumigation, 5-6 weeks at 25°-27°C at Kisumu in Kenya. A fortnightly sampling period after fumigation is suggested for the first 2 months and then monthly after that.

- ASHMAN, F., 1965, Sampling Methods used in an Insecticide Field Trial in Kenya to Measure Population Levels of Three Pest Species in Stored Maize. Proc. 12th Int. Congr. Ent., London 1964, 1965., pp 639-40.

- CASWELL, G.H., 1960, Damage to Maize by Calandra oryzae in South-West Nigeria. Journal West Afr. Sci. Assoc. 6 (1) pp 49-62.

  Examination of samples of maize obtained from market traders in Ibadan, Nigeria, over a period of 14 months showed that damage to maize by Calandra oryzae, the only important pest of stored maize in this region, is probably due to the fact that farmers use a system of shifting agriculture and store their maize on their farms where Calandra is not endemic. Should practice of central storage become more common, damage is likely to increase, unless precautions are taken.

- GILES, P.H., 1969, Observations in Kenya on the Flight Activity of Stored Product Insects, Particularly Sitophilus zeamais, Motsch. Journal Stor. Prod. Res. 4 (4) pp 317-29.

  The study showed that field infestation from stored products insects can be significantly reduced by placing grain stores at greater than 800 metres from maize fields. Using suction trap catches, the flight range of Sitophilus zeamais was shown to be at least 400 metres, although accurate flight ranges could not be determined. Using the same methods, flight periodicities of Cadra cautella, Sitotroga cerealella, Tribolium castaneum and Typhaea stercorea were determined. The study also showed the peak flight activity of Sitophilus zeamais to be between 15 and 17 hours, depending on total population near the trap and climatic conditions, particularly the temperature at 15 hours and the amount of sunshine between 13 and 18 hours, followed by a discussion of the practical significance of these discoveries.

- GILES, P.H. & ASHMAN, F., 1971, A Study of Pre-Harvest Infestation of Maize by Sitophilus zeamais, Motsch. (Coleoptera curculionidae) in the Kenya Highlands. Jrnl Stor. Prod. Res. 7 (2) pp 69-83.

  Insect damage in storage is related to the amount of infestation prior to storage. Tightly sheathed cobs appeared less likely to be infested.

- GOLDBLATT, L.A., 1968, Aflatoxin and its Control. Econ. Bot. 22 (1)

- LeCONTE, J., 1965, Marche de l'Infestation par Sitophilus oryzae dans les Silos à Mais du Sud-Dahomey. Congrès de la Protection des Cultures Tropicales, 23-27 Mai 1965, pp 69-75.

- LILLEHOJ, E.B., FENNELL, D.I., & HARA, S., 1975, Fungi and Aflatoxin in a Bin of Stored White Maize. J. Stored Prod. Res. 11 (1) 47-51.

- OYENIRAN, J.O., 1970, Microbiological Studies on Maize Used as Poultry and Livestock Feed at Two Research Farms in Ibadan, Western State of Nigeria. NSPRI Tech. Rep. No. 6, pp 47-56.

  Twenty samples of white and yellow maize were obtained from two research farms each month for 10 months and analysed for moisture, mould and aflatoxin contents. A positive relationship was found between moisture content and mouldiness. Aflatoxin contents were usually found to be fairly high (i.e. above 1,000 micrograms/kg). Six of the twenty mould species found on the samples were found to predominate.

- OYENIRAN, J.O., 1971, Microbiological Examination of Maize from Various Sources soon after Harvest. Nig. Stor. Prod. Res. Inst., Tech. Rep. No. 3, pp 27-32.

  This report discusses results of studies on moisture, mould and aflatoxin contents of samples of maize collected soon after harvest, from a number of locations. The relationships of discoloured and insect damaged

grains found in the sample to microbiological deterioration is also discussed. The author found that even at high moisture contents, maize on the cob was damaged less by mould than was shelled maize.

- RAWNSLEY, J., 1968, The Origin and Succession of the Insect Pests of Stored Maize. Ghana Crop Res. Inst. Ann. Rep. 1963/64 pp 18-20.

  Cadra cautella, Sitophilus oryzae, Tribolium castaneum, Oryzaephilus mercatore and Cathartus quadricollis on infesting grains at harvest or post-harvest stages persist in them through the plant storage stage. Results of observations on a batch of stored maize, giving figures for the build-up of Sitophilus oryzae and total damage over time, are reported. A trial in which 2% malathion applied at 100 cu. ft. per full grain sack of shelled maize is described, as are the results of a second trial, using 1% solution of oil-based pyrethrum on desheathed maize. Both trials show fairly good results.

- UGANDA, 1950, Pests of Stored and Drying Maize. Dept. Agric. Uganda, Rec. Inves. No. 3, pp 86-91.

(ii) Environmental

- CASWELL, G.H. & CLIFFORD, H.T., 1960, The Effect of Moisture Content on the Germination and Growth of Fumigated Maize Grain. Emp. Journal Exp. Agric. 28 (110) pp 139-44.

  Viability of maize was found to be affected by both moisture content and a CCl_4-ethylene dichloride fumigant mixture. For the first 3 months, unfumigated grain at 13% moisture content remained viable. At higher moisture content the viability was not maintained, the rate of loss increasing with moisture content. The fumigated grain, however, required a moisture content of below 11% in order to maintain viability for 3 months. With fumigated grain, a depression of growth increased with increases in the moisture content. This did not happen with unfumigated grain.

- HYDE, M.B. & OXLEY, T.A., 1960, Experiments on the Airtight Storage of Damp Grain. Introduction: Effect on the Grain and the Intergranular Atmosphere. Ann. Appl. Biol. 48 (4) pp 687-710.

- HYDE, M.B., 1969, Hazards of Storing High-Moisture Grain in Airtight Silos in Tropical Countries. Trop. Stor. Prod. Info. No. 18, pp 9-12.

- KENYA, 1963, Report of Kenya Dept. of Agric. Ann. Rep., Vol. 1, pp 44.

  In a study of methods designed to prevent moisture condensation on the inside surfaces of plastic sheets left on large stacks of bagged maize as a mechanical barrier to insects, it was found that serious deterioration of the maize occurred only in sacks which had a high initial temperature (as a result of active insect infestation) at the time of building the stacks, and even then few bags were affected.

- MILTON, R.F. & JARRETT, K.J., 1969, Storage and Transport of Maize. 1) Temperature, Humidity and Microbiological Spoilage. World Crops 21 (5) pp 356-7.

  Short discussion of spoilage of bulk maize during transport by sea, (including a brief review of relevant literature). Broken grains are the first part of the bulk to spoil due to heating. In the experiment described, grains were ground (to 1.5 mm sieve size) and kept in controlled relative humidity and temperature conditions until mould growth was apparent. Results give conditions (time, temperature and relative humidity) at which Aspergillus spp. were first apparent. A. glaucus and A. restrictus were first to appear. A relative humidity of 70% seemed to be the lower limit above which growth of microorganisms is possible.

- MILTON, R.F. & JARRETT, K.J., 1970, Storage and Transport of Maize. World Crops 22 (1) pp 48.

  Discusses the relative humidity and moisture content equilibrium in maize and gives desorption and absorption isotherms. Increase in temperature causes increased relative humidity in the interstices in maize of a given moisture content, and can lead to microbial activity and spread of heating, with subsequent damage to maize. This is of particular importance in the case of maize carried by sea.

- MILTON, R.F. & JARRETT, K.J., 1970, The Storage and Transport of Maize. World Crops 22 (2) pp 96, 98, 99.

  Microbiological spoilage of maize being shipped is very much governed by temperature. However, dry maize is a very good insulant. Because of this, it is possible for maize loaded under warm conditions and shipped to cool climates to be warm in the centre and cool on the outside. This temperature gradient results in the migration of moist air from the interior to the periphery. Condensation may occur, thus causing spoilage of the maize.

- OKAFOR, N., 1968, The Ecology of Micro-Organisms in a Self-Heating Maize Stack. Nigeria Journal Sci. 2 (1) pp 35-40.

4. Storage Research and Improvement

(i) General

- ANANHANZO GLELE, A.M., 30/6/71, Resultats des Experimentation sur la Conservation du Mais. I.R.A.T., Dahomey, Note DY, 07, 21 pp.

- ANANHANZO GLELE, A.M., 11/9/72, Le Point sur les Systèmes de Stockage du Mais. IRAT, Dahomey, Note DY No. 22, 5pp.

- ANIM-MANU, F., 1958, Departmental Maize Campaign Work in the Ashanti-Mampong Agricultural District. Ghana Farmer 2 (1) pp 30-31.

  Includes notes on maize storage.

- ASHMAN, F., 1964, Insect Reinfestation Problems in Fumigating Maize on the Kenya Coast. Bull. Ent. Res. 55 (1) pp 139-46.

- BOURIQUET, G., 1962, Plant Pests and Diseases in Some African Territories. FAO Plant Prot. Bull. 1962 10 (6) pp 130.

Dahomey: An investigation on maize conservation in farm granaries has been carried out in the south of the country. It seems that the main problem is the prevention of infestation in the field rather than that of contamination in the granary.

- BROADBENT, J.A., 1970, Maize Storage Problems in the Humid Tropics, Lecture Notes, 13 pp.

Most maize storage in Nigeria is done by farmers. The author feels that no drying problem exists unless the maize is shelled soon after harvesting,when aflatoxin develops. He reports on a USAID silo storage scheme in Western Nigeria, which failed probably due to poor management and because it was on too big a scale. Individual dryer and storage units are now being tried with more success, although one ton appears to be too large a unit for each farmer. A lindane-based dust is being distributed and marketed for the protection of sorghum and has impressed farmers. Cost is 3 shillings per ton of grain. Lindane may be replaced due to residue problems. He suggests that a gradual improvement of traditional methods may be the best way to improve storage. Price differentials are essential for improved quality. A study of the system of weights and measures is needed to replace sales by volume, which fail to penalize infested maize. A market board would probably not work in practice. Other countries, he says, like East Africa, are considering returning to private enterprise. He feels the Nigerian system is functioning quite efficiently.

- CASWELL, G.H., 1956, Grain Storage Problems in Southern Nigeria - Paper given at 6th CIAO Conference held at Sao Thome, August 1956, pp 8.

- CHADHA, Y.R., 1962, Sources of Starch in Commonwealth Territories. IV, Maize. Trop. Sci. 4 (1) pp 13-37.

Storage: Descriptions and discussion of methods of maize storage in Kenya are given including both traditional and improved large-scale storage. The most common insect pests of stored maize are listed. It is recommended that maize be dried to 14% moisture content before being stored. Methods of drying and fumigating with lindane powder are noted.

- CORNES, M.A., 1963, Further Investigations into the Small-Scale Storage of Maize in Cribs. NSPRI Ann. Rep., Tech. Rep. No. 12, pp 101-108.

The first part of this report deals with a comparison of three types of maize cribs, as to the drying rate they allow. Results show that there is no significant difference between the three crib types. The author concludes that crib storage of maize in South-West Nigeria is not likely to be successful due to the high ambient relative humidity in the area, resulting in an uptake of moisture by the maize. The second part of the study compares the effectiveness of Sevin and BHC dusts against insects of stored maize cobs in cribs. At the dosages applied, BHC dust proved more effective than Sevin treatment, primarily due to the longer persistence of BHC.

- DELAPORTE, J.L., 1965, Preservation of Maize in Togo. Chambre de Commerce et d'Industrie, Marseille: Congrès de la protection des cultures tropicales. pp 23-27, and 59-62.

Detailed descriptions of traditional maize storage structures in various regions of Togo are given. A list of the insects commonly found in stores and their percentage of the total insect population are outlined. Recommendations are made for small modifications to traditional storage structures and on the use of fumigants, including: method, timing, and concentrations. The training of extension officers is discussed and a list of subsequent fumigant sales to farmers given. Results of a trial using DDT dust are outlined and a proposal for next year's experiments given.

- DELASSUS, M. & POINTEL, J.G., 1970, Results of Work and Research by IRAT in Africa and Madagascar on the Protection of Stored Food Products. Agron. Trop. Nogent 25 (10-11) pp 941-955.

Maize cribs, dipping of cobs in insecticidal solutions and use of plastic bags and carbon tetrachloride are described.

- DE LIMA, C.P.F., 1973, A Technical Report on Twenty-Two Grain Storage Projects at the Subsistence Level in Kenya. National Agric. Lab. PROJ/RES/AG21.

Twenty-two grain storage projects at the subsistence level were conducted in Kenya during 1970/71 and a questionnaire analysis during 1971/72. The project consisted primarily of treatments of farmers' stores with 50% wettable powder lindane before harvest, dusting of cobs with lindane at 10 ppm and shelled maizeor other cereals at 1 ppm lindane. The project failed to encourage farmers to adopt improved storage techniques due to a time lag between statistical significance of the treatments and the economic significance, the increase in fixed costs necessitated, and the poor economic structure at the rural level. Nine supplementary reports were done during the project covering: subjective analysis, cost-benefit analysis, analysis of treatment effectiveness, insect population damage, bulk density, weight loss, and moisture content, storage strategies, damage models, economic consideration and sequential sampling. The author concludes that for a successful storage improvement project, the storage system should be very simple, a complete analysis of the system should be made, storage insecticides for maize should be encouraged and settlement schemes and divisional co-operatives should be the location of further storage experiments.

- DeLIMA, C.P.F., Undated, The Conduct of Field Infestation Surveys and the Economic Use of Their Results. Nat. Agric. Lab., Nairobi, 13 pp.

- FAC-IRAT-INRA, 1968, Conservation du Mais et des Haricots au Togo. (Résumé des travaux effectués du 7 août 1962 au 31 janvier, 1968, pp 31.

- FAO, 1975, Report on Work Carried Out in Nigeria to June 1975 at African Rural Storage Centre IITA Ibadan under FAO, TF/AFR/45 (DEN) and Work undertaken in the Participating Countries to June 1975.

- FERNANDEZ YEPEZ, A., 1947, Contribucion al Estudio del Alma ceramiento del Maize en el Tropico. (Contribution to the Study of Maize Storage in the Tropics.) 3rd Conferencia Intramer. Agric. Caracas, 67 pp 5-42 (in Spanish).

  Reports tests on various locations, structures, structural materials, moisture contents and fumigation.

- FORSYTH, J., 1957, Maize Storage in Ashanti: Journal Publ. of the Sci. Council for Africa, South of the Sahara. No. 31, pp 71-76.

  Describes the traditional Ashanti methods of storage in Ghana with a list of the most common insect pests found associated with maize. Compares extent of insect damage in cobs treated with 0.45% gamma BHC and untreated grain. Dried and dusted maize in sacks was stored in a plywood silo and gave satisfactory results. The first silo was situated at an agricultural station, and in the following years was gradually adopted by farmers in the area.

- GHANA, 1967, Protecting Shelled Corn against Pests. Crop Res. Inst. Farming Guide, CC/1 pp 1-7.

  This pamphlet was written for extension workers and explains a method for protecting grains from storage insects. Well dried grain and a burlap sack lined with a plastic bag is used. The contents of a capsule of 5 mls. ethylene bromide are squeezed out onto the top halves of 3 maize cobs. One cob is placed at the bottom, middle and top of the sack as the grain is put in. The plastic bag is then tied off and sewn up as normal.

- GILES, P.H., 21/8/65, Kenya File 27A, Trop. Stor. Prod. Centre.

  At Kitale, lindane resistance in Sitophilus zeamais is a problem. The maize ears are on the plant for at least 14 weeks, so pre-harvest infestation is a problem. The seed producers in the area must, by law, grown their maize seed at least ½ mile away from the nearest store. 85% of the maize crop in Kenya is grown for the African farmer's own consumption and so far, nothing has been done to control infestation in their stores.

- GILES, P.H., 1967, Maize Storage: The Problem of Today. Trop. Stor. Prod. Info. (14) pp 9-19.

  The article provides a guide for large-scale farmers in Kenya on the storage of maize on the farm. It discusses moisture and infestation criteria for grades of maize sold to the central agency, methods of storing maize ears in cribs and of shelled maize in bags or in bulk, drying of grain after harvesting, prevention of insect attack by spraying stores and by adding insecticides to the stored product (only lindane, malathion and pyrethrins are permitted) and fumigation

of the grain with phosphine or with a CCL_4 plus ethylene dichloride mixture. Photos show an unsatisfactory type of crib and a well-constructed one, with the floor raised above the ground. Trials indicated that, under Kitale conditions, grain should be dried artificially or in the sun if more than 13mm of rain falls in the week prior to harvesting.

- GOARIN, P. & POINTEL, J.G., Dec. 1972, Contribution de l'IRAT/Senegal a l'étude de la Conservation des Stocks de 1967 ã 1971.

- HALL, D.W., 1968, Trop. Stor. Prod. Centre/1708/68, Uganda.

  The moisture content of maize at harvest is approx. 20% and it can be expected to dry to a level of approx. 14% in 2 months of crib storage. Shelling should be done at a moisture content of approximately 15%. Initial dusting of cobs with lindane (1.0%) should occur immediately they are put in the crib. 4 ozs. of dust is enough for 9 cu. ft. (approx. 200 lbs. of shelled corn). For For longer term storage, the author recommends spraying outer crib surfaces with 1% a.i. lindane (eg. gammalin 20 or other proprietory emulsifiable concentrate formulation) at 1 gal. per 1000 sq. ft. of surface. Repeat every 2 months.

- JOFFE, A., 1963, The Effect of Physical Disturbance or "Turning" of Stored Maize on the Development of insect infestation. 1) Grain Elevator Studies. South Afr. J. of Agric. Sci. 6 pp 55-64.

- KENYA, 1956, Maize Storage on Farms. Kenya Info. Office, K.I.O. Fortnightly (420) pp 2.

  The article discusses insecticides in cribs, insecticides for maize in bags and precautions against mustiness and moisture contents.

- KENYA, 1962, Kenya Dept. of Agric. Ann. Rep. 1 pp 31.

  A large stack of approximately 30,000 bags of maize was held under polythene sheets for 6 months. Due to heavy insect infestation causing heating before the initial methyl bromide fumigation (1½ lb./1000 cu. ft.), moisture translocation took place and the top layer suffered from moulding. When the stack was uncovered, no live insects were found, indicating fumigation was effective and reinfestation was prevented by the plastic sheets. A study of methods to prevent moisture migration when using plastic sheets as a barrier against reinfestation has been started.

- KENYA, 1961, Entomologists Rep., Kenya Dept. of Agric., Ann. Rep. pp 41.

  A trial at Mombasa showed admixture of malathion dust to grains gives superior protection to dusting the tops of sacks only. Description and discussion of a search for Trogoderma granarium in transport vehicles coming from Tanzania and Rhodesia (including lake ships) is given. A crib experiment to test 3 strengths of pyrethrum-piperonyl butoxide and 2 strengths of lindane based on diatomite is reported. Methods and results are given and

the recommendation that cribs be treated with 4-8 ozs. of 1% lindane to 9 cu. ft. of cobs with a heavier application on the exposed sides than in the mass centre is made. Pyrethrin dusts are suitable for unexposed maize but not effective where there is exposure to the sun.

- KENYA, 1964, Kenya Dept. of Agric. Ann. Rep. for 1964, 1 pp 37.

  There was a continued incidence of heavy populations of maize weevil, Sitophilus zeamais attacking maize before harvest The "Kitale" strain of weevil was found to have a marked degree of resistance to lindane. Reinfestation of bagged sacks of maize and other produce following fumigation was particularly rapid and severe at Mombasa. The maize marketing board chose synergized pyrethrum as the dust to be used for admixture to maize purchased by them for the 1964/65 storage season.

- KOCKUM, S., 1958, Control of Insects Attacking Maize on the Cob in Crib Stores. East Afr. Agric. J. 23 (4) pp 275-9.

  Details of the cribs and the experimental design and materials are given for a trial to examine protection of cob maize against insects. Results were:

  1) 0.5% gamma BHC dust in wire net walled cribs gave good control over 6 months, but not over 13.
  2) No difference in protection resulted from reducing the diluent from 8 ozs. to 4 ozs. per 9 cu. ft. and doubling the BHC content.
  3) No reduction in damage resulted from surface dusting with pure pyrethrum powder of 1.26% pyrethrin content.
  4) Different crib wall construction: wire net, Napier grass, grass thatch and hessian cloth, show no difference in level of protection.
  5) Complete protection for 13 months was given by dusting with 0.06% lindane at 8 ozs. per 9 cu. ft. and surrounding the crib with a wall of hessian cloth treated with 40 g. lindane plus 4 g. coumarone in 1 l. of kerosene per 100 sq. ft.

- KOCKUM, S. & GRAHAM, W.M., 1962, Prevention of Insect Reinfestation in Bagged Maize. Trop. Agric. 39 (3) pp 231-245.

- KOCKUM, S., 1965, Crib Storage of Maize. A Trial with Pyrethrin and Lindane Formulations. East Afr. Agric. and For. Journal 31 (1) pp 8-10.

  Descriptions of cribs and treatments used in a storage experiment in Kenya on different insecticide treatments are given. Results gave conclusive evidence of the superiority of the 1.0% lindane dust against Sitotroga moth in crib storage with open wire net walls. Earlier experiments show that lower concentrations are required if crib walls are covered with hessian cloth treated with lindane. Inside the bulk of cobs, very low concentrations of pyrethrin gave almost complete protection, but on the outside, no strength was effective. Pyrethrin is likely to be effective in cribs such as the Argentine crib or some African clay-covered "Ngala", especially if the walls are treated with an insecticide. Differences in degrees of protection between east and west walls were marked. Biological control by the parasite Anisopteromalus calandrae is pronounced on the sides facing west, which are weakened by a deterioration in the pyrethrin strengths.

- LE CONTE, J. & BASSON, C.A., 1963, Le Problème de la Conservation du Mais en Epis dans le Sud Dahomey; Etude du Dévelopement de l'Attaque par Sitophilus oryzae en Champ et en Magasin. Agron. Trop. 18 (10) pp 969-84.

  A survey of farmers' stores showed that only 50% of maize heads were undamaged. This figure did not vary much with time from harvest. A trial showed that DDT dust on heads stored in the sheath had little effect, but when used on shucked heads, it was effective. Observation showed that intermediate mealy-type maize was more susceptible to infestation than the vitreous type maize. The level of infestation increased quickest during the first 5 months and then levelled off. Field dusting should occur about 3 weeks before harvest.

- LE PELLY, R. & KOCKUM, S., 1957, The Control of Stored Products Insects in Kenya. Publ. of the Sci. Coun. for Africa, South of the Sahara, No. 31, pp 107-115.

  Various successful fumigation techniques and dosages for protection of maize in bag storage, bags under gas-proof sheets, railway trucks and walls of stores are described.

- LEPIGRE, A.L. & POINTEL, J.G., 1971, Protection of Maize Stored in Traditional Togolese Granaries. Trop. Stor. Prod. Info. (21) pp 7-12.

- MOULD, H.A., 1971, Grain Storage in the Humid Tropics. Cocoa Marketing Board, Newsletter 48 pp 21-4.

  The article reviews various maize storage practices and problems in Ghana. The author states that traditional storage methods are still preferred by farmers to modern methods recently introduced. He briefly described the traditional barn or crib methods used and also the more modern silo and hessian bag methods. He outlines the main storage problems of maize, the insects, sprouting, heating, bacteria and fungi and describes control measures for insects and rodents. Control of the main insect pests of stored millet, sorghum and rice are also discussed briefly.

- NIGERIA, 1956, West African Stored Products Research Unit, Ann. Rep., Dept. of Mkt. and Exports, Nigeria, pp 31-34.

  This report consists of brief descriptions and reviews of several tests being carried out by the unit, including:

  1) General description of grain storage position in Nigeria.
  2) General description of storage in the Northern region, including underground pit storage.
  3) Infestation of cobs of various maize varieties at harvest - list of insect species found.
  4) Damage to various maize varieties in store - assessment of maize varietal resistance to C. oryzae.
  5) Preliminary trial on use of cocoa dryer for drying maize - description of dryer and results of two trials with maize.

- NIGERIA, 1964, Notes on Fumigation of Seed for Storage using Phostoxin. Min. of Agric. and Nat. Resour. Nigeria, Moor Plantation n/d.c.

  Phostoxin fumigation of small bulks of seed maize has proved effective in killing all insects with no effect on viability. A description is given of a method of subsequently storing the seed. In-bag fumigation with phostoxin and stack fumigation, are also described. A report of results of a trial on bulk fumigation of a silo using 60 tablets through 5½ tons of grain is included.

- OLUFADE, A.O., 1974, A Review of Insect Pests of Maize and Their Control in Nigeria. Niger. J. Entomol. 1 (1) 57-62.

- PANHUYS, H. & KUYPERS, 1972, Rapport de Mission sur la Situation du Mais au Dahomey. Cotonou-Lome (PAM-PNUD-FAO) 20 pp.

- PROCTOR, D.L., 1961, The Safe Storage of Maize. Trop. Stor. Prod. Info. (3) pp 54-63.

- PREVETT, P.F., 1972, Storage of Rice and Maize; Nigeria, Pilot Project for Rural Employment Promotion in the Western State. FAO ESR:ILO/FAO:NIR 36, 43 pp.

  The report covers an evaluation of present storage facilities and practices in South-West Nigeria for rice and maize and recommendations on the types of storage needed at all level. Background information on the project, on research done by the Nigerian Stored Products Research Institute and the "master farmer scheme". Observations on traditional and improved traditional methods of storage and drying are presented along with a discussion of present storage silo usage (which is deteriorating) and a review of proposals, and present work of the MANR/USAID drying and storage programme. Conclusions and recommendations for improvement are presented.

- RAWNSLEY, J. & MURTORA, L.C., 1970, The Preservation of Maize on the Cob in Farmers' Cribs. Ghana Acd. of Sci. Crop Res. Inst., Ann. Rep. for 1967, pp 26.

  Fumigated, stripped maize cobs were treated with Sevin (carbonyl) by dipping into Sevin/water solutions of various concentrations. Treated cobs were placed into baskets and into cribs. Storage losses in baskets were recorded after 5 months. Results are tabulated.

- STEWARD, R., 1968, Rapport sur la Conservation du Mais. Volontaires du Corps de la Paix, (du Service de la Protection des Végétaux), Lomé 16 pp.

- WHEATLEY, P.E., 1967, Trop. Stor. Prod. Centre (1331/67, Kenya.

  The sheath appears to be important in reducing field infestation by storage pests, particularly Sitophilus zeamais. Cobs with exposed tips are more heavily attacked by weevils than those completely covered. Whether weevils can penetrate sheaths or not is not known. Problems of de-sheathing and drying in the sun or in cribs are noted. Suggested fumigation techniques are outlined. A number of alternative insecticides for Kenya are listed.

(ii) Structures

- CAH. AGRIC. PRATIQUE PAYS CHAUD, 1967, The Crib, a Means of Preserving and Storing Maize on the Ear in Réunion. (3) pp 171-5.

  Storage of maize ears in cribs i.e. cages of wire mesh screen is practiced in many countries and is considered the best method for peasant farmers. The construction of a crib based on a design made by the agricultural research station at Réunion, is described. The dimensions may vary according to the prevailing climatic conditions, in particular, air humidity and the risk of storm damage and to the size of the crop. It is recommended to dust with lindane during filling and to spray the sides with lindane at weekly intervals. Insects and birds will usually cause a loss of 2% of the value of the crop.

- CORNES, M.A. & RILEY, J., 1962, An Investigation of Drying Rates and Insect Control in a Maize Crib with Improved Ventilation. W.A.S.P.R.U. Ann. Rep. pp 72-8.

  It was found that locally made cribs had insufficient ventilation to allow rapid enough drying of maize cobs in Western Nigeria to prevent mould and to allow malathion dust to work. A description and costing of a new design for cribs, allowing better ventilation is given. Trials were conducted with various insecticidal treatments in both local and improved cribs. All the insecticides were effective; however, differences in drying rates were only slightly in favour of the new cribs due, it is believed, to unusually favourable weather.

- CUTLER, J.R. ET AL, 1957, Maize Storage in 44-gallon Oil Drums (Western Region). West Afr. Stor. Prod. Res. Unit, Ann. Rep. 1957, pp 42-43.

- GHANA, Undated, Grain Storage Silo for the Ghanaian Farmer, Ghanaian-German Agric. Dev. Project, Northern and Upper Regions. Univ. Press, Kumasi, 24 pp.

- HYDE, M.B. ET AL, 1973, Airtight Grain Storage (With Particular Reference to Hot Climates and Developing Countries). Agric. Services Bull. No. 17, AGS:ASB/17, FAO.

  The bulletin is intended as a review of the experimenta groundwork and practical application of airtight grain storage practices particularly in Kenya and Argentina. The bulletin is in four sections, the first dealing with the scientific principles involved, followed by a report on small-scale structures, including traditional methods such as gourds. The last two sections discuss large-scale structures, one of these being the Cyprus bins in Kenya. History, design and construction techniques, the operation and performance and costs are discussed. There is also a discussion on what to expect if complete airtightness is not achieved.

- OYENIRAN, J.O. & BROADBENT, J.A., 1968, A Preliminary Experiment on the Airtight Storage of Damp Maize. Nigerian Stor. Prod. Res. Inst. Tech. Rep. No. 9 pp 71-75.

  Yellow maize samples from the University Farm at Ibadan were harvested, shelled, mixed and tested for moisture, insect damage and microflora. The maize was divided into two lots, one being sealed in polythene bags within sealed 45-gallon drums. Eight weeks later the samples were again tested. The experimental maize showed little damage; a small increase in insect damage, fewer micro-organisms and disappearance of all mould species. The control maize showed a 2 to 3-fold increase in insect damage, increases in micro-organisms and a change in the type of microflora.

- POINTEL, J.G., 1974, Farm and Village Level Grain Storage Techniques other than Silos. Working Paper No. 7. West African Seminar on the Volunteer Role in Farm and Village-Level Grain Storage, Dahomey, December 13-23, 7 pp.

- VICENTE, M. ET AL, 1972, Storage of Grains in Plastic Bags. I. Maize. Arg. Inst. Biol. 39 (2) pp 93-9.

  Maize grain of 10,12,13,14 and 16% moisture content was stored for 6 months in plastic bags of 0.15 mm thickness, at room temperature in Brazil. Moisture content increased to 14-18% and moulds were found to develop at 15%. Thus, only the 10% initial moisture maize remained mould-free. It was also found that the weevil Sitophilus zeamais could not survive in the plastic bags.

- WILKIN, D.R. & GREEN, A.A., 1970, Short Communication - "Polythene Sacks for the Control of Insects in Bagged Grain." J. Stor. Prod. Res. 6 pp 97-101.

(iii) Protection

- ADESUYI, S.A., 1969, A Preliminary Trial on Drying of Seed Maize, Sorbead "W". Tech. Rep., Nig. Stor. Prod. Res. Inst. No. 8, pp 63-69.

  Small quantities of seed maize stored with sorbead "W" in a plastic bag gave quicker drying than when the mixture was kept in Viluer jars or separated in a dessicator. Sorbead "W" did not affect viability of the seed. Phostoxin tablets controlled insects and did not affect viability. A thorough mixing of maize and sorbead "W" was essential. About 50% sorbead of maize, by weight was required to give drying to a safe level in a short period. This did not seriously increase the total volume. The sorbead "W" can be sieved out using a 15/64" sieve, dried and reused. Costs at 3°/4° per lb. were 186 pounds per ton of seed, but the material can be reused.

- ADESUYI, S.A. & ADEYEMI, S.A.O., 1973, A Comparison of Malathion, Iodofenphos. and Bromophos for the Control of Insect Infestation on Maize in Cribs. Tech. Rep., Rep. Nigerian Stor. Prod. Res. Inst. 1970 No. 5,pp 39-46.

  The article reports a trial to find insecticide dusts with low mammalian toxicity to replace BHC dust for fumigating maize in cribs. 1% malathion at 30 ppm, 5% iodofenphos at 20 ppm and 1% bromophos at 20 ppm were used and monthly samples taken from each for insect damage analysis and moisture content determination. Malathion and iodofenphos were effective over 9 months and bromophos for 7 months. All were more effective than BHC at 10 ppm. Assessment of contamination and taint in food and the economy of using these insecticides requires further work.

- ADESUYI, S.A., 1974, The Appropriate Application of Insecticides to Farm and Village-level Grain Storage. Working Paper No. 5, Seminar on the Volunteer Role in Farm and Village-level Grain Storage, Dahomey, 13-21 December, 14 pp.

- ASHMAN, F, 1963, The Chemical Control of Stored Food Insect Pests in Kenya. *J. Agric. Vet. Chem.* 4 *(2)* pp 44-48.

- ASHMAN, F., 1966, An Assessment of the Value of Dilute Dust Insecticides for the Protection of Stored Maize in Kenya. J. Appl. Ecol. 3 pp 169.

  A series of insecticidal dust formulations of malathion, bromodan and pyrethrum on maize were compared for effectiveness against insect reinfestation following fumigation. Results are given, indicating the best mixture being Pyrethrum 0.2% plus 1% piperonyl butoxide at 4 ozs. per bag. Sampling methods and methods for determining extent of damage are reviewed, and the suggestion made that measuring the level of dust from insect feeding is the best for determining damage level.

- ASHMAN, F. & KOCKUM, S.P.H., 1967, Ann. Rep. Dept. of Agric, Kenya, 1964. Vol. II - Rec. of Investigations, pp 34-35.

  Reports on various insecticide admixture trials for maize at Kisumu. Synergized pyrethrin dust containing 0.2% pipethrins and 1% piperonyl butoxide gave good results at 4 ozs. per 200 lb. bag. The Maize Marketing Board adopted this recommendation for 1964/65. Further trials are reported underway on 1% malathion plus 0.1% and 0.2% pyrethrins used with a synergist. Results so far are good at 4 ozs. per 200 lbs. of shelled maize.

- ASHMAN, F. & KEMPTON, R.J., 1967, Stability of Malathion Dust Formulations Manufactured in Kenya. East Afr. Agric. For. J. 33 (2) pp 212-218.

  Malathion dust on a base carrier of Kenyan kaolin and admixed with maize at 8 ppm proved to be unsuitable. The moisture content portion of the kaolin used was too high, but subsequent laboratory tests showed that this was not the cause of the instability. The local Kenyan kaolin is not regarded as a good carrier for malathion,

especially with the addition of Kenya gypsum. Further tests were done with organic formulations (in this case wheat flour) and malathion. They were also found unsatisfactory and the explanation is proposed that the degradation was due to a complex of factors, including enzymatic action.

- B.A.S.F., 1972, A New Method of Preserving Harvest Crops. Agric. News Letter pp 5-8.

  Treatment of wet cereals and other high-moisture crops with Luprosil (propionic acid) promotes good storage stability without the need of drying, cooling or ventilation. Luprosil works by preventing the growth of micro-organisms and by inhibiting the action of enzymes, which decompose carbohydrates. Luprosil at 0.1-0.2% has been effective in preventing growth of fungi such as Aspergillus flavus in maize.

- CASWELL, G.H. & CLIFFORD H.T., 1958, The Effect of Ethylene dichloride and CCL_4 on the Germination and Early Growth of Maize. The Empire J. of Exper. Agric. 26 (104), pp 365-372.

- COAKER, T.H., 1959, "In-Sack" Treatment of Maize with Insecticides for Protection against Storage Pests in Uganda. East Afr. J. of Agric. 24 (4) pp 244-250.

- CORNES, M.A., 1962, A Preliminary Test of Sevin for Use in Maize Cribs in the Western Region of Nigeria. W.A.S.P.R.U. Ann. Rep. pp 70-71.

  It has been shown that gamma BHC dust is the most effective insecticide against Sitophilus zeamais. Residues of BHC should not exceed 2.5 ppm just prior to milling. Sevin, an insecticide with low mammalian toxicity is also effective on Sitophilus (sp) but no tolerance limits have been established. Description of a trial to test Sevin on infested maize is given. The results are outlined and the author states that the trial showed Sevin to be a very persistent insecticide.

- CORNES, M.A., 1965, An experiment to Compare the Effects of CCL_4 and Phostoxin on the Germination and Subsequent Growth of Maize. N.S.P.R.I. Ann. Rep., Tech. Rep. No. 14, pp 85-87.

  Testing of the viability of maize seeds stored at two levels of CCL_4, with two dosages of phostoxin and hermetically stored after being artificially dried to 9.4%, is described. Good insect control was achieved in all trials. The viability and vigour of the seeds and plants in field tests after 3 months storage, showed all but the highest level of CCL_4, (30cc/cu. ft.) to be good.

- CORNES, M.A., ADEYEMI, S.A.O., & QURESHI, A.H., 1967, An Assessment of the Value of Phosphine and Ethylene Dibromide for the Control of Pests in Grain Stored in Polythene-lined Sacks. Tech. Rep., Nigerian Stored Prod. Res. Inst., Ann. Rep. No. 13, pp 113-121.

- DAVIES, J.C., 1958, Aluminium Phosphide for Bulk Grain Fumigation in Uganda. East Afr. Agric. J. 24 pp 103.

- DAVIES, J.C., 1960, Experiments on the Crib Storage of Maize in Uganda. East Afr. Agric. J. 26 (1).

  Trials on the crib storage of maize in Uganda are described. 8 oz. of 0.5% gamma BHC to 9 cu.ft. of cobs gives excellent and economical control of storage pests for over 15 months.

- DIAGNE, Daouda, 1973, Contribution à l'Etude des Formulations de Poudres à Poudrer à Base d'Attapulgite Sénégalaise Associée au Malathion ou au Bromophos. Travail de Fin d'Etudes Roneotype. Faculté des Sciences Agronomiques de l'Etat Gembloux (Belgique), pp 158.

- GRAHAM, W.M. & KOCKUM, S., 1958, Protection of Bagged Maize with Lindane and DDT. Trop. Agric. 35 (4), pp 292-298.

- GRAHAM, W.M. & KOCKUM, S.P.H. 1961, Admixture of Malathion and Lindane with Bagged Maize. Bull. Ent. Res. 52 (4) pp 727-739.

- GUNDU RAO, H.R. & HAREIN, Ph. K., 1972, Dichlorvos as an Inhibitor of Aflatoxin Production on Wheat, Corn, Rice, and Peanuts. J. Econ. Entomol. 65 (4), pp 988-9.

  In the U.S., wheat, maize, rice and groundnuts were inoculated with aspergillus flavus and trials were conducted using treatments of different levels of dichlorvos, before or after inoculation. Control was best achieved with wheat treated at 20 ppm before inoculation. The conclusion reached was that dichlorvos may be used as a control to aflatoxin production, but the concentrations needed are significantly greater than those needed for insect control in stored grain.

- HALL, D.W., 1966, Maize Meal as a Carrier for Insecticidal dust. Trop. Stor. Prod. Centre /313/66, File: Kenya 21.

  Maize contains enzymes capable of breaking down malathion and it is more than likely that moulds contain similar enzymes. If maize meal is to be used it must be fresh and not have incurred rancidity.

- JSA, A.L., ET AL, 1970, On the Effect of Certain Fumigants on the Overwintering Corn Borers' Larvae. Agric. Res. Rev. U.A.R. 48 (1) pp 43-7.

  In Egypt, maize stalks harbouring overwintering Ostrinia nululalis and Chilo agamemnon larvae were exposed to methyl bromide and hydrogen phosphide at rates varying from 16 to 28 and 3 to 9 g. per m^3 respectively. The corresponding exposure periods varied from 8 to 24 and from 24 to 72 hours. Fumigation with methyl bromide at 20 g/m^3 for 10 hours or at $16_9/m^3$ for 24 hours gave 100% control of the larvae of both insects. Hydrogen phosphide failed to give any satisfactory results, even when applied at the highest rate combined with the longest exposure period.

- KENYA 1961, Ann. Rep. of the Senior Entomologist, Kenya Dept. of Agric. Ann. Rep. p 5.

  The article reports on maize storage trials with pyrethrum dust and lindane. Results after 7 months are given and show it to be quite an effective treatment. The main pests found are listed and a description of their

methods of attack in a crib, given. It was shown that all insecticides had given complete protection in the body of the crib, but on the top and sides to a depth of one foot, the cobs were unprotected from Si otroga attack by pyrethrum. Lindane gave good protection, but it was found that 1% lindane in diatomite at 8 ozs. to 9 cu. ft. was better than the 0.5% lindane rate.

- KENYA 1962, Rep. of Kenya Dept. of Agric. Ann. Rep. for 1962, Vol. II. Record of investigations.

  A crib storage trial for maize carried out at Kitale during the 1962/63 storage season, showed that 1% lindane dust treatment gives satisfactory maize weevil control, even though a heavy field infestation was encountered.

- KOCKUM, S. 1953, Protection of Cob Maize in Cribs. E. Afr. Agric. J. 19 (2) pp 69-73.

  Summary:

  1. A crib experiment with dust treatments of cob maize showed that a treatment with 8 ozs of 0.4% gamma BHC in diatomite to 9 cu. ft. of cob maize provides almost complete protection against insect damage over 6 months. A product containing pyrethrum in diatomite also gave good results. A short discussion of the distribution of damage and the moisture content in the crib follows.

  2. A second experiment on residues of BHC showed that even at high initial doses (100 ppm) only small residues remain.

- KOCKUM, S. 1965, Crib Storage of Maize: A Trial with Pyrethrin and Lindane Formulations. E. Afr. Agric. For. J. 31 (1) pp 8-10.

  Cribs at Nairobi were divided into compartments, each with one wire net wall and filled with unhusked maize. The maize was treated with 1 or 0.5% lindane or 0.14 or 0.07% pyrethrin plus 10 times as much of piperonyl butoxide at a rate of 0.9 kg. dust per m^3 of ears. In untreated compartments after 8 months, 29.5% of the kernels at the interior of the mass were infested by Sitotroga cerealella, while only 0.25 - 0.56% in treated compartments were infested. In the outside layers, lindane proved much more effective than pyrethrins and 1% was better than 0.5% lindane. On the side exposed to the afternoon sun, the pyrethrins had a negative effect. It is expected that different results would be obtained with different types of cribs or if a beetle rather than a moth was the infecting agent.

- LIMA, C.D.F. de., 1972, Lindane Resistance in Field Strains of Sitophilus zeamais (Motsch.) in Kenya. J. Stor. Prod. Res. 8 (3) pp 167-75.

  Forty field strains of Sitophilus zeamais from 23 locations were tested for their susceptibility to lindane impregnated papers as compared to a standard from a susceptible strain. Resistance ranged from 1 to 49 times the standard control. The strain with highest resistance tended to originate in areas where lindane has been in regular use on stored maize.

- McFARLANE, J.A. & SYLVESTER, N.K., 1969, A Practical Trial of Pyrethrins-in-Oil Surface Sprays for the Protection of Bagged Grain against Infestation by Cadra cautella (WIK) (Lepidoptera Phycitidae) in Kenya. J. Stor. Prod. Res. 4 (4) pp 285-293.

- NDUKWE, K.U. & CORNES, M.A., 1965, Effect of Lindane on th Germination of Maize seed. Nig. Stor. Prod. Res. Inst. Ann. Rep., Tech. Rep. No. 15, pp 89-90.

  Samples of seed maize treated with BHC dust at two levels (20 and 15 ppm) for 3 and 6 months showed no adverse effect to germination of the seeds due to insecticidal treatment.

- PARKINS, E.A., 1965, Trop. Stor. Prod. Centre, File: Kenya - Insect.

  The resistance of Sitophilus zeamais to lindane was confirmed in a strain from Kenya. Alternative control measures are discussed.

- POINTEL, J.G., 1969, A Trial and Survey on Togolese Maize Granaries. L'Agronomie Tropicale 24 (8) p. 709.

  Three insecticides, zeidane, lindane and malathion were applied to unhusked ears of maize in Togolese maize granaries to test their effectivenes. A study on sampling techniques to be used in these granaries was also conducted. The author reports that a survey to test the treatments put into practice in 1962 has been undertaken in the maize growing areas of Togo.

  His trials showed that:
  1. The percentage of undamaged ears remained constant throughout storage, regardless of the type of treatment.
  2. Zeidane effectively protects against weevils in previously attacked ears for five months. Lindane and Malathion are effective for only 3 months.
  3. A random sample of 100 ears from the upper part of the granary is representative.

  From the survey the author concluded that the treatment programme has been effective. Also, treatment at initial storage is efficient but regular treatments throughout the storage period produce better results.

- PYRETHRUM POST., 1964, Protection of Stored Maize from Insect Attack. 7 (4) p 11.

  Pyrethrin /piperonyl butoxide and malathion, on inert bases, when admixed with fumigated maize gave 6 months protection against Sitophilus zeamais and T. castaneum.

- RAWNSLEY, J. 1965, The Post-Harvest Preservation of Maize and Beans. Ghana Farmer 9 (1) pp 35-39.

  Discusses use of ethylene dibromide capsules in plastic-lined bags of shelled maize.

- TROP. STOR. PROD. CENTRE, 18/11/1965, Minutes of the 50th Meeting of the Pest Infestation of Stored Products Committee, File: Kenya 21.

  It is reported that insecticide trials with pyrethrins in a number of cases are no longer giving the degree of control achieved initially. Malathion is working better.

- TROP. STOR. PROD. CENTRE, 20/12/1065, Minutes of the 50th Meeting of the Pest Infestation of Stored Products Comm. File: Kenya 21.

  Dr. Parkin has shown that the maize weevil in Kitale is showing resistance to lindane. Weevils from the same source were used in laboratory bioassays, and Fenitrothion, malathion, pyrethrins, tribuphon and a mixture of malathions and pyrethrins gave good results and will be tested in a large scale crib trial at Kitale. Bromodan and carboryl failed to give adequate kill at the concentrations used (up to 40 ppm).

D. Large Scale and Off-Farm Storage

1. Research and Improvement

(i) General

- ADESUYI, S.A., 1969, Western State Grain Storage Sites. (2nd Progress Report). Nig. Stor. Prod. Res. Inst. Tech. Rep. No. 7, pp 49-52.

  A survey was conducted of the Western State government maize storage sites established around 1964, to encourage proper drying, storage and marketing of maize and the formation of farmer co-operatives around the sites. All silos were found to be empty. Discussions with farmers and co-op. union personnel indicated that inefficient handling of drying and storing equipment and failure of the organised market system proposed were the principal reasons the silos were not being used.

- ADESUYI, S.A. & AGENI, F.A., 1973, An Assessment of the Storage Facilities and Storage Problems at the Pilot Project for Rural Employment Promotion in the Western State - I.L.O/FAO Western State Project OTTA, typed notes 7 pp.

- BAKER, A.A., 1970, Report on the First Phase of the Kenmore/ NRDC Project with 40-ton Farm Silos in Kenya. Unpubl. Report, Min. of Agric.

- BAKER, A.A., 16 July 1970, A Case for Modified Cleaning Facilities on the Cyprus Bin Sites. 65th Meeting of Pest Infestation and Stored Prod. Comm., Nairobi.

  Describes an air-extraction method, which could be used to improve dust removal and collection in the existing screening apparatus. Estimated cost £3000.

- BAKER, A.A., 1972, Report on a Four-Year Secondment to the Kenya Gov't as Stored Products Entomologist. TPI, R238, 1967-72, 40 pp.

  The publication describes a number of research projects on bulk grain storage, handling and pest control and discusses the results. In particular, it reports on the 40 Cyprus bins, hermetic storage trials at Kitale for maize, ten silo experiments, using a variety of types, results of insecticidal dust trials at a number of points to control Tribolium, Sitophilus, and Ephestia, fumigation trials with phostoxin and detia in railway

  cars carrying maize, bulk handling by rail and road, and moisture meter, quality control studies. Recommendations on proper methods or need for further study, are made after each section, and a proposal presented for a Stored Products Unit, including its organisation, purpose and in-service training and extension programmes.

- BARKER, P.N., 1969, Bulk Grain Storage Trials in Kenya. Unpubl. Report, Kenya Farmers' Assoc. (Co-op.) Ltd.

- BLANE, M.A. & FORSYTH, J., 1957, Co-operative Maize Storage: Ashanti. Ghana Farmer 1 (6) pp 216-217.

  Shelled maize is dried to 14% moisture content, treated with lindane dust, and stored in silos of various types.

- BLANE, M.A., 1958, Maize Storage - Ashanti. Ghana Farmer 2 (3) pp 106-109.

  Brief descriptions are given of traditional crib storage in Ghana. The new co-operatives are examined and their central storage of shelled maize in plywood silos, use of lindane dust admixture and drying in a Nu-way "in-bag" dryer are outlined.

- CASWELL, G.H., 1962, Investigation on Maize Storage in Two Concrete Block Bins and one Steel Bin. WASPRU/UCI grain storage project, WASPRU Ann. Rep. pp 81-82.

  In September 1959, maize dried to 13% moisture was loaded into 2 concrete block bins, one with a false floor and a steel bin. Before loading the bins were swept, the walls sprayed with 0.1% DDT and 0.5% gamma. BHC dust applied under roofing felt which was used to cover the floor. Samples taken after 3 months showed that insect damage was higher at the surface than lower down. After sampling in February, all 3 bins were fumigated using 5 litres of a 1:1 mixture of CCL_4 and ethylene dichloride to each bin. In May and June the bins were emptied. The concrete with the false bottom had the highest level of infestation. The felt is likely to be a source of infestation unless thoroughly treated.

  The commonly found characteristic that infestation is concentrated at the surface of the bins may be due to an inherent tendency of insects to move upwards or that grains near the surface are looser so that movement is easier.

  Moisture levels in the 3 bins are given. Concludes that maize can be stored effectively for 8 months if fumigated. However, regular examinations and fumigations, when necessary, should be done.

- CIDA - TANZANIA 1973, Society Co-operative Storage. Operating procedures. Pilot project of grain store. Study for Government of Tanzania and CIDA, Larmont Mill Process Consultants Ltd., Calgary Alberta, Canada 46 pp.

- CORNES, M.A. & ADEYEMI, S.A.O., 1964, Tech. Rep. No. 15, "A Survey of Grain Storage Sites in Western Nigeria."

- CORNES, M.A. & OYENIRAN, J.O., 1968, Fumigation of Maize in an Aluminum Silo Using a 1:1 CCL_4 Ethylene-Dichloride Mixture. Tech. Rep., Nig. Stor. Prod. Res. Inst. No. 12, in a report for 1967, pp 109-11.

  The current method of fumigating silos with the above mixture is examined. The work showed that although this fumigant gives good control of pests in grain, reinfestation and some localised survival are made possible by excessive ventilation at the eaves of the silo. Other conclusions include: the rapid post-fumigation development of a large population of Oryzaephilus mercator indicates that this species may become a serious pest in silo storage. A recommendation is proposed that comparable trials using physical barriers a) to control gas leaks and insect reinfestation and b) to prevent reinfestation, but not gas leaks should be done in order to differentiate between the possible sources of post-fumigation infestation.

- GHANA FARMER, 1958, Maize Mechanisation of Shelling, Drying, Storage, and Marketing. 2 (1) pp 30-1.

- GILES, P.H., ET AL, 1966, Memorandum on Maize Storage.

  The present storage and handling methods have been largely determined by the fact that over 90% of Kenya maize is produced by subsistence farmers, who sell their maize in quantities of less than one bag. It is essential to have a small unit of storage: the 200 lb. bag. In good years, the marketable surplus is only 10-12% of the total maize produced. As agricultural techniques improve and subsistence farming is replaced by cash crop farming, bulk storage techniques will become more attractive. Silo storage has a definite place at Mombasa, where the present storage facilities are inadequate. Tropical conditions are nearly optimal for insects and moulds and inadequately stored grain can deteriorate rapidly, but Kenya has some ideal storage locations at altitudes above 800 ft. on main rail routes at Uplands and Equator - Timboroa.

  Reserve stock stores and all new stores should be constructed of concrete or stone and concrete. A list of recommendations is given under headings:

  1. The points that should be considered when building new bag stores.
  2. The way bulk handling could be introduced.

- GRAHAM, W.M., 1970, Warehouse Ecology Studies of Bagged Maize in Kenya: i) The Distribution of Adult Ephestia (Cadra) cautella (Walker) (Lepidoptera Phycitidae); ii) Ecological Observations of an Infestation by E. cautella; iii) Distribution of the Immature Stages of E. cautella; iv) Reinfestation Following Fumigation with Methyl Bromide Gas. Journal Stor. Prod. Res., 6 (2) pp. 147-180.

- GREIG, D.J. & FORSYTH, J., 1962, A 500-ton Silo Storage Unit for Use in Ghana. Pap. CCTA/FAO Symposium on stored food. Freetown 20-24 Feb. 1962.

  Discusses existing co-operative system and suggested 500-ton units, including handling, drying and estimated costs for Ghana.

- GURNAH, A.M., 1973, Large Scale Maize Production in Ghana. World Crops 25 (6) 308-311.

  The paper includes recommendations and need for artificial drying and storage of the crop until a suitable selling price can be obtained. Storage is in bags and metal and butyl silos. The main storage pests are listed: Calandra (Sitophilus) oryzae, Mussidia nigruenella, and Tribolium castaneum. Fumigants effective in control of these pests are discussed: spraying with 0.6% Sevin, and in-bag fumigation using one 5 ml capsule of ethylene dibromide/bag. Fumigation of bulk grain in silos by ethylene dibromide at 50 ml/ton.

- HALL, D.W., CORBETT, G., ET AL, 1969, Storage and Handling of Wheat and Maize in Kenya. Min. of Agric., Kenya, p 108 and app. 1-11.

  This is an extensive report of a working party on the future storage policy for maize and wheat in Kenya. It reviews the wheat and maize policies now in effect and the planned policy to switch to bulk handling through port development and bulk storage silos at Mombasa. This is followed by sections devoted to wheat and to maize handling. The present production figures, marketing and storage systems and transport facilities are reviewed for maize and conclusions and recommendations on the design and operation of bulk storage systems, improved loading and grain handling and a bulk grain drying system are presented, along with a general costing for these systems. Problems and recommended improvements to bag storage facilities are also detailed. Geographical locations for the new system of silos, etc., are recommended. Details for the reorganisation of the administrative agencies involved (including extension services) are outlined.

- KENYA, 1957, Dept. of Agric., Ann. Rep.

  Descriptions of fumigation trials on maize using methyl bromide under gas-proof sheets are given. Trials on methyl bromide penetration of polythene-lined sacks are also reported. Experiments on cob maize with lindane dust fumigation, lindane dust mixed with diatomite and various crib structures are discussed. Shelled maize in 200 lb. sacks, treated with 3% pyrethrins and 3% piperonyl butoxide showed very good results at 8 ozs. per 200 lb. of maize. A large scale stack experiment, using 4 stacks, each with a different treatment: surface layer dusting with 0.5% lindane-diatomite or 1.5 lb. DDT layer-by-layer at 3 oz/bag both on dunnage floors with 10% DDT dust or on untreated floors. No significant difference was found between the four treatments, all were fairly successful.

- KENYA, Dec. 1968, Second Ann. Rep., Balance Sheet and Accounts for the Period ending 31.7.1968. Maize and Produce Board, Nairobi.

  Maize exports for the period were 3,096,374 bags, the highest ever. With the completion of the present building programme, the board will have a storage capacity of 3.6 million bags by the end of 1969. Successful interim experiments, were carried out in the use of phostoxin for in-truck fumigation (this is necessary to avoid congestion at the coast).

- LATTA, R. & IVES, N., 1966, A Plan for Mechanisation of Grain Storage in Kenya, East Africa. Assoc. Senior Consultants Inc., Wash., for USAID, 96 pp.

  An assessment of the current grain storage programme is presented, including a history of controlled maize and wheat prices, maize supply fluctuation, moisture content requirements, insect control programmes, existing storage facilities, their construction and operating procedures. A plan is then presented for improving the grain storage system. Drying systems, storage construction layouts, weather considerations, insect control and an economic assessment of the new system are described. A summary of recommendations is included.

- OXLEY, T.A., 1955, Report to the Government of Kenya on the Storage and Handling of Maize and Wheat. Pest Infestation Lab., Slough.

- PATTINSON, I., 1969, The National Agric. Prod. Board, Tanganyika, Part 2: Storage Problems. Trop. Stor. Prod. Info. (17) pp 23-31.

- PEACE CORPS/Dahomey, 1971, Aug. Two-ton Cement Store Silos built on Pillars. Construction Manual. 11 pp.

- PEACE CORPS /Dahomey Oct. 1971, Silo en Douves de Cement pour le Stockage des Grains. Manuel de Construction, 5 pp.

- PEACE CORPS/Dahomey, Sept. 1972, Construction Manual for 2-ton Capacity Cement Stave Silo. 7 pp.

- PREVETT, P.F., 1967, Storage Requirements for the Proposed Agric. Prod. Mrkt. Board. Rep. to the Government of Uganda. T.S.P.C., F.A.O., 46 pp.

  The purposes of the study were to evaluate the storage requirements for a proposed agric. prod. marketing board in Uganda, which would handle minor crops (maize, groundnuts, mixed beans, finger millet, and sorghum). One section of the report is devoted to the current production and market situation, comprises mostly quantitative figures. The present storage situation is evaluated by region, describing primarily in tabular form, the number, location, capacity, construction type, and condition of most of the large scale storage facilities of co-ops. and traders. These tables are followed by a section devoted to general discussion of storage facilities by region. Recommendations for improving buildings or rejecting storage facilities (bag and bulk), are made, as well as farmer storage education, moisture testing, and quality control centres, and improved transport for bulk handling.

- RAWNSLEY, J. & MOULD, H.A., 1959, Fumigation of American Maize. Ghana Cocoa Market Board, Insect Control Unit, Publ. No. 10.

  American maize was fumigated with methyl bromide after 3 months in storage in Southern Ghana in an attempt to control Sitophilus oryzae, Tribolium castaneum, Tenebroids mauritanicus, Cadre cautella and Plodia interpunctella. The authors believe that the infestation was introduced from the United States,especially in the case of the moth, Plodia interpunctella.

  Over 2 months, a 3% weight loss was recorded in unfumigated maize. The insect damage resulted in a reduction in density, but not in volume of the product, because the insects cavitated the grain, leaving the overall size the same. A recommendation is made to fumigate all imported grain if it is to be stored, to prevent introduction of new pests.

- SERVANT, 1969, Etude sur la Commercialisation du Gari et du Mais dan le Sud du Togo, SEDES, 74 pp plus graphiques et Annexes (ronéoté broché).

- TANGANYIKA, 1953, Grain Storage Dept., Ann. Rep. 1952/53, Dar-es-Salaam.

- TAYLOR, R.W.D., 1968-70, Rep. on a 2-year Secondment to the Kenya Government for an Investigation into Fumigation and Related Topics. TPI, Trop. Stor. Prod. Centre No. R-111, 26 pp.

  The publication reports on the tests carried out to establish a viable method of fumigation for the large scale grain storage facilities of the Maize and Produce Board and of railway trucks whilst in transit. The construction of the airtight grain stores are explained and results of two fumigation trials with methyl bromide are documented. The problems of the cost of making stores airtight and overcoming condensation decided the government not to pursue this type of storage. Fumigation trials with methyl bromide in railway trucks are reported and the use of an indicator socket to assess the effectiveness of fumigation described. The efficiency of maize and maize germ meal fumigation under gas-proof sheets is discussed as well as phosphine fumigation of stack maize. Recommendations are included.

- THOMPSON, R.H., 1973, Rapport au Gov't Dahomey sur la Mise en Place d'Installations de Fumigation dans le Port de Cotonou. FAO/DEN/TF 97, TF-DAH 37 (DEN) 24 pp.

- UGANDA'S GRAIN PLANT, 1952, "Pilot Scheme for the Commonwealth", Anon., New Commonwealth, Aug. 4th, 24 pp 128-9.

  A general article describing the grain storage and conditioning plant at Jinja, Uganda, after one year's operation. It is hoped that the plant will allow Uganda to process all her own maize, and in the future, her other cereal and bean crops. Various modifications being undertaken are described including guarding against the risk of dust explosions and overcoming the wear problem in the pipes of the conditioning plant. Comparisons of foreign matter in the grain are made between British and Ugandan maize. Storage capacity is not up to Uganda's total production, therefore, much of the maize will be given directly to millers after conditioning.

(ii) Structures

- BAKER, A.A., 1974, Trials with Maize and Wheat stored for Long Periods under Hermetic Conditions in the Kenya "Cyprus Bins." Trop. Stor. Prod. Info. 26 pp 33-37.

  This article reviews the use of cyprus bins in Kenya

for long-term storage of maize and wheat. Trials conducted over a considerable time measured grain temperatures and moisture, oxygen and CO_2 levels, insect infestation levels, microbiological spoilage, germinating capacity after storage and the free fatty acid levels of the grain. Results indicated that the bins can be used successfully. Losses were less than 1% compared to 2% normally encountered with conventional methods. It was found though, that dust must be removed from the grain before storing and moisture content should be low. Some loss in seed viability occurred (greater for wheat than maize) and some loss of quality from rancidity was evident.

- BARCLAYS OVERSEAS REVIEW, April 1968, pp 41-2.

  Kenya: 40 cyprus maize bins built in Kitale were opened in March 1968. Each bin can contain in bulk, the equivalent of 15,000 bags in hermetically sealed conditions under which it is possible to preserve the maize for four years.

- COLLINGS, H., 1960, Hermetic Sealing of a Stack of Maize with Bituminous Roofing Felt. Reprinted from Trop. Agric., Vol. 37, No. 1.

- DAVIES, J.C., 1960, Storage of Maize in a Prefabricated Aluminium Silo in Tropical Conditions. East Afr. Agric. J. 25 (4) 225-228.

  A 20-ton prefabricated aluminium silo was erected at Kawanda, Uganda, in June 1957, as part of a programme to test silos of various types of construction and materials. Construction of the silos is described as well as the sampling techniques used for testing infestation levels. Results of the initial sampling with names of insects discovered, are given. The samples were incubated and insect counts determined and correlated with damage extent. Moisture contents were determined and effects on grain reported. Observations made upon emptying the silos after spraying with CCl_4 and ethylene dichloride are discussed. The infestation by Calandra oryzae was controlled by this fumigation.

- LE CONTE, J., 1965, La Conservation par Poudrage des Mais en Silos Paysans dans le Sud du Dahomey. Congrès de la Protection des Cultures Tropicales, 23-27 Mai, 1965, pp 77-80.

- ROBERTSON, J.V., October 1968, Trials with Small Capacity Metal Grain Silos in Dar-es-Salaam, Tanzania. East Afr. Agric. and For. J.,

- SWAINE, G., 1954, Underground Storage of Maize in Tanganyika. East Afr. Agric. J., 20 (2) pp 122-128.

  Describes trials in three 120-ton pits for periods of 379, 446, 466 days.

- SWAINE, G., 1957, Trials on the Underground Storage of Maize of High-Moisture Content in Tanganyika. Bull. Ent. Res. 48 (2) pp 397-406.

(iii) Protection

- ADESUYI, S.A. & CORNES, M.A., 1966, An Assessment of the Efficacy of Phostoxin for the Control of Grain Pests in Silos. Part II, Nig. Stor. Prod. Res. Inst. Ann. Rep. 1966, Tech. Rep. No. 14, pp 109-111.

  A concrete silo was filled with 6 tons of maize (heavily infested with insects) and fumigated under a polythene sheet with 5 tablets of phostoxin per ton. The tablets were placed one foot from the bottom and from the top of the grain. Samples taken from top, middle and bottom areas after 4 days showed the dosage to be sufficient for good insect control. Some insect eggs, however, appeared to be resistant to the fumigant.

- ADESUYI, S.A., 1969, An Assessment of the Efficacy of Phostoxin for the Control of Grain Pests in Silos, III. Nig. Stor. Prod. Res. Inst., Tech. Rep. No. 5, 1969, pp 39-44.

  A 10-ton capacity aluminium silo filled with maize was fumigated under a polythene sheet with phostoxin tablets at a concentration of 4 tablets per ton. Nine sampling points at the top, middle, bottom and outlet of the silo were monitored for phosphine concentration. The efficacy of the phostoxin was determined four days after fumigation. Results show that phosphine concentrations were at a maximum after 5 hours and in some points after 21 hours, but that virtually no gas reached the outlet. After 53 hours, the gas was virtually gone. Except at the outlet, the fumigation was very effective against the adult and pre-adult stages of all the insects found.

- ADESUYI, S.A., 1969, Post-Fumigation Protection of Maize in Aluminium Silos with 1% Malathion Dust. Tech. Rep. No. 6, Nig. Stor. Prod. Res. Inst., pp 45-48.

  The effectiveness of 1% malathion dust at 10 ppm on maize which had been fumigated with phostoxin in a 10-ton aluminum silo, was tested for protection against reinfestation by Sitophilus zeamais and Tribolium castaneum every week for 16 weeks. The dust residue was found to be effective against Sitophilus zeamais for 15 weeks, but against Tribolium castaneum for only 1-2 weeks. From the 9th week, reinfestation by Tribolium castaneum and Cryptolestes occurred, but not by Sitophilus zeamais.

- CORNES, M.A. & ADEYEMI, S.A.O., 1968, Phosphine Fumigation of Maize in an Open-Top Steel Bin. Nigerian Ent. Mag. 6 pp 115-117.

  Procedures adopted for fumigating an open-top 40-ton steel bin of maize at Glora in Western Nigeria with phosphine are described. Maize was heavily infested with Sitophilus zeamais and Tribolium castaneum, and 160 phostoxin tablets (4 per ton) were applied at various points. An attempt was made to estimate the concentration-time product (ct) achieved during fumigation and this was related to insect mortality. The minimum recorded ct. was 45 mg. per hour per litre (at 85°F) at the grain surface. At all other points, the theoretical ct needed to give 99% mortality of the papae of S. oryzae was exceeded (i.e. 57.6 mg per hr/litre). No live S. zeamais were found and mortality of T. castaneum was almost complete.

- EL-RAFIE, M.S., EL GHAR, M.R.A., & METROALLY, F.A., Undated, Effect of Certain Grain Protectants on the Population of Grain Insects under ommon Methods of Storage in the U.A.R. Bull. Entom. Soc. Egypt., No. 3, pp 157-165 from Ent. Abst. 2 (1) p 64.

  The effects of the insecticides DDT, Malathion, pyrenone and katelsousse on the population of Sitophilus, Rhizopertha and Tribolium in Hindy wheat and early American corn were compared over a 14-month period. Pyrenone was the least effective. Katelsousse was slightly less effective than the other two insecticides (the number of tribolium increased significantly). The type of grain and storage method also influenced the insect population. In the short term, maize appeared better protected and bags seemed to become less infested than silos. The location of sampling revealed no difference in silos while in bagged grain, the bottom sacks were generally most infested.

- GILES, P.H., 1965, A Provisional Report on a Series of Trials of Phosphine Fumigation of Stored Products in Kenya, File - Kenya 27.

- HAYWARD, L.A.W., 1963, Infestation Control in Stored Groundnuts in Northern Nigeria. World Crops 15 (2), pp 63-67.

- HEAPE, R.J., 10th March 1967, Trop. Stor. Prod. Centre

  4240 Tons of Maize were fumigated in silos at Mombasa, Kenya, with MeBr at 2 lbs./1000 cu. ft., for 48 hrs. before shipping to Birkenhead. Insect infestation found upon arrival in the U.K. is outlined. Explanations of the cause of reinfestation are attempted. Bromide residue levels are listed.

- SWAINE, G., 1961, Plant Pests of Importance in Tanganyika. Min. of Agric. Bull. No. 13, 44 pp.

  Storage of maize on the cob: Cleanliness of the store is most important. Regular surveying, and removal and burning of dust and spillage is essential. Every 2 months the store should be sprayed with 50% lindane wettable powder diluted at ¾ oz. per gallon of water. One gallon of spray is sufficient for 1000 sq. ft. Before storing, the store should be sprayed as above. Cobs put into the store should be dusted with 0.5% lindane in diatomite dust at ½ lb. per 9 cu. ft.

- UGANDA PROTECTORATE, 1962, Dept. of Agric., Storage of Agric. Prod., Maize Storage, p 16.

  Bagged maize should be treated with 2-3 ozs. of 1% gamma BHC dust or 3 ozs. of 2% malathion dust per bag, as they are being stacked. Sprayers, if fitted with agitators, can be used for applying wettable powders to the layers of bags at the rate of 8 ozs. per 50% DDT wettable powder or 1 lb. of 25% malathion per 1 gal. of water, applied to 1000 sq. ft. The surface of the stack should be resprayed at 6-8 weeks intervals.

  Admixture of dust in grain on a large scale is usually impracticable, but where bagging and sewing facilities exist, can be used. BHC dust mixed at the rate of 4 ppm has given satisfactory control for 8-9 months in Ugandan conditions. Malathion 0.7% dust at 4 ozs. per 200 lbs. is also satisfactory.

2. Economics of Storage

- BOMERS, J.B.G., 1972, Economics of Corn Storage. Mimeo, Co-op. Dept., Bamenda, Cameroun.

- FAO/UNDP, 1973, Agricultural Marketing (Storage). Mktg. Dev. Bureau, Min. of Agric., Dar Es Salaam, FAO/UNDP Project SF TAN 27, Report No. 19.

- UPTON, M., 1962, WASPRU/UCI, Grain Storage Project - 2. Costs of Maize Storage, 1959-60. WASPRU, Ann. Rep. pp 83-86.

  The maize was dried at the rate of 1-ton per day, removing 6% water from maize with an initial moisture content of 19%. Details are given of the various costs, the labour cost being 10 shillings per ton. Total cost for cleaning of bins before storage was 4 pense per ton, including BHC powder for dusting. Cost of fumigation using a 1:1 mixture of CCL_4 and ethylene dichloride is less than 3 shillings per ton. Storage costs are broken down into depreciation and costs of various treatments. The sale value of the maize is adjusted for loss on drying and insect damage.

E. Marketing

1. Traditional

- ACQUAAH, B.P., 1974, The Internal Distribution of Food in Ghana. Document No. 19, Nat. Food and Nutrition Conference, April 8-10, 8 pp. plus others.

- ADEYOKUNNU, T., 1970, The Market for Foodstuffs in West Africa. O.D.U., J. West Afr. Stud. ILE-IFE (3), pp 71-86.

  The author believes that foodstuff marketing in Western Nigeria shows some of the characteristics of the modern market concept (creation of utility for consumers and of money and real income for farmers). He concludes that many improvements to the marketing system remain. He recommends that improvements be made in market information, quality and quantity of produce, and that standard weights and measures be instigated.

- AFFAL, E.N., 1962, Seasonal Variation in Maize Prices in Ghana. Tr: Ghanaian Bull. Agric. Econ. 2 (2) 24-31 pp.

  Seasonal price fluctuations for maize are shown to exist and recommendations for a system of price controls are given.

- ALVIS, V.Q. & TEMU, P.E., 1968, Marketing Selected Staple Foodstuffs in Kenya. Dept. of Agric. Econ. & Office of International Programmes, West Virginia University, Morgantown, W. Virg.

- AKEN'OVA, M.E. & ANTHONIO, Q.B.O., 1968, The Marketing of OFADA Rice in Ibadan City - A pilot survey. Part I. Bull. Rur. Econ. Social, Ibadan, 3 (2) 207-34.

  This section of the study discusses the problems of rice distribution i.e. poor storage, transportation costs and lack of grading and standardisation. Some of the problems studied in detail are: The cost of transporting the rice 400 miles from its point of production, the different types of local measures used, wholesale and retail margins, and retail price fixing. The different types of transportation used are analysed. They find that 93% of traders use porterage at some stage, 12% use rail, 23% cart and 2% bus. Road transport, although more expensive than rail, is used more often due to the time factor. Wholesalers were found to have a 25% market margin and 10% profit margin. The authors believe that marketing disabilities provide a good explanation for the reluctance of farmers to invest in technical improvements in food production.

- CLEMM, M. von, Undated, Agric. Prod. and Sentiment on Kilimanjaro. Economic Botany 18 (2) pp 99.

  The author has written an agro-social-economic account of the Chagga peoples farming the slopes of Kilimanjaro in Tanzania. Coffee and bananas form the main crops, but most people also cultivate maize and beans in the lowlands, alcng with some finger millet. Although grown principally for home consumption, most people hope for a saleable surplus of maize. The author says that 40 shillings or more per bag of mealies is always assumed. In reality, however, because of uncertain rainfall, there is either no surplus for marketing, or else a glutted market, which brings prices down to 20 shillings a bag. Evidently some assembly of maize occurs, as the author reports seeing lorry loads of maize cobs coming up from the bush for storage.

- EHRLICH, C., 1956, The Economy of Buganda, 1893-1903. Uganda J., March 1956.

- GHANA, 1960, Market Trade, University College of Ghana. African Business Series, No. 2, Accra.

- GHANAIAN BULL. AGRIC. ECON., 1962, The Maize Industry of Ghana, 2 (2) pp 1-11.

  The article reports on a survey of the maize production areas, history, marketing, prices and problems of cultivation. Maize seems primarily produced as a cash crop although significant quantities are consumed on the farm.

- GHANA FARMER, 1963, The Maize Industry of Ghana, 7 (4) pp 146-153.

  Generally, Ghana is a net importer of maize coming principally from Togo and the Ivory Coast. The 1951-61 import figures are given. Markets tend to be flooded with maize in August and September, dwindling until June and July, when little maize is available.

  The writer feels that a planned production and storage programme could overcome the fluctuations. The major maize crop is harvested in July or August and a minor crop from the South comes in in January. Maize is the primary staple of Ghana. The dough can be cooked in several ways; boiled to make ke key, fried or baked to make aboloo.

- GUESTEN, R., 1968, Studies in the Staple Food Economy of Western Nigeria. African Stud. IFO, Inst. Wirt. Forsch, Munchen, No. 30, 310 pp.

  A number of aspects of the staple food economy of Western Nigeria are discussed. The first section reviews the existing data on production, consumption and trading of foodstuffs. The second section deals with the place of the food economy within the developing economic structure. The third section contains the main part of the study which is an analysis of movement of foodstuffs from producers to the areas of greatest demand, including: volumes, commodity patterns, and direction of movements.

- HODDER, B.W., 1962, The Yoruba Rural Market. In: Markets in Africa, Bohannan and Dalton (eds), Evanston, Ill.

- HODDER, B.W. & UKWU, U.I., 1969, Marketing in West Africa. Studies of Markets and Trade Among the Yoruba and Ibo, Ibadan UNI Press, 254 pp.

  The two studies examine the patterns of commodity exchange and distribution in West Africa. Distribution is primarily accomplished through rural periodic markets, daily markets and retail and wholesale stores in the town. The influence of geography, politics and economic factors in the establishment of markets and the economic functions of markets are examined.

- ILORI, C.O., 1967, Economic Organisation of Traditional Markets in Yoruba Land. Nig. Agric. J. 4(2) pp 38-44.

  A discussion of the place of Yoruba markets in the Nigerian economy is presented. Aspects of the markets described include: market evolution, recent trends in marketing, imported commodity trade, and classification of different types of markets. The various roles in the marketing chain are defined, including such outside agents as commission agents, brokers, and food contractors. Discussions are also presented on the female domination of the distributive trade and reasons for people choosing trading as an occupation.

ILORI, C.O., 1968, Economic Study of Production and Distribution of Staple Food Crops in Western Nigeria. Diss. Stanford Univ., 260 pp.

  An analysis is presented of the production, consumption and marketing of staple food crops in West Africa. An attempt was made to determine the percentage of food grown that reaches the market place. 14 to 20% of the 70 farmers surveyed did not produce excess food for sale. Results indicate that there is a direct relationship between the amount of processing a foodstuff undergoes and the percentage of total production that is marketed. However, there is an inverse relationship

between the amount of processing required and the number of farmers engaged in production of that foodstuff. Women were found to dominate the retail market trade and men, the wholesale trade for staple foods. Marketing structure appeared to be influenced by tradition to some extent.

- KENYA FARMER, 1957, Maize Marketing - Recommendations. Mar./April.

- KURANCHIE, P.A., May 1974, Maize Production and Marketing in the Gomoa Area of the Central Region of Ghana. Food Res. Inst., Accra.

- LAMADE, W., 1966, Two Ghanaian Wholesale Markets for Maize. Z. Ausl. Landu. Frankfurt, a.M. 5 (2) pp 92-103.

  The study investigates two wholesale markets selling maize in Ghana. It examines the number of buyers and sellers, the volume of trade, criteria for price formation, middlemen's costs and profits and their relationship to producers, credit arrangements between buyer and producer and suggestions for improving the system of marketing, especially the large fluctuations in prices.

- MBILINYI, S. & MASCARENBAS, A., Research on Subsidiary Food Marketing in Dar Es Salaam. ERB Paper No. 68.16.

- MIDDLETON, J., 1962, Trade and Markets among the Lugbara of Uganda. In: Paul Bohannan and George Dalton, (eds.) Markets in Africa, Evanston, Ill.

- POLEMAN, T.T., May 1961, The Food Economies of Urban Middle Africa: The Case of Ghana. Food Res. Inst. Stud., Food Research Institute, Stanford, Calif.

- REUSSE, E., NYARCO, S., & APPIAH DANQUAH, E., 1966-68, Report on Maize Farm Storage and Marketing Survey., FAO, 9 pp.

  The survey showed that farmer maize storage capacity was adequate, (80-200% of the main season harvest), storage periods averaged 2-7 months, estimated storage losses were 8% of harvest and maize appears to be a cash crop primarily. Farmer marketing practices are discussed and it appears that farmer remuneration is well balanced between maize growing regions. Transport charges are discussed and seem to be affected most by distance, road conditions, and level of supply of available transport. Main trading takes place between rural assembly and urban wholesale markets. A detailed discussion of the wholesale trade including market margins is presented along with brief discussions of the retail trade. Farmers appear to receive 58% of the ultimate retail price of grain. All the information gathered in the survey is tabulated in the appendix.

- SINGH, C., 1966, Report of the Maize Commission of Inquiry, Nairobi (Gov't. Kenya).

  The commission examined the maize shortage in Kenya, the marketing and distribution systems and possibilities for improving them and the purported inefficiencies and corruption in the marketing and distribution system. An examination of the supply and demand levels and the factors affecting them was also made, within the limits of available statistics.

- TANZANIA, 1956, Maize, Tanzania-varieties, Harvesting, Marketing, etc. Overseas Food Corp., H.O.C. paper No. 195, pp 66-69 and 129-33.

- THODEY, A.R., 1968, Marketing of Staple Foods in Western Nigeria. USAID, Stanford Research Inst., Vol. 1, 2 & 3.

- THODEY, A.R., 1969, Analysis of Staple Food Price Behavior in Western Nigeria. Diss. Univ. Ill. 516 pp.

  The study is based on information from Ibadan and other centres in Western Nigeria. It examines the organisation of the marketing system for yams, cassava, maize, rice and cowpeas, the process of price formation, spacial, temporal and inter-commodity price behaviour, price efficiency and market imperfections. The author concludes that improved market performance could be achieved by developing the market-related infrastructure, credit and public information services, because the main inhibitant to market performance is the market environment, not the structural organisation or the traders themselves.

- THORNTON, D.S., 1971, Agriculture in South East Ghana. Vol. 1, Summary Rep., Univ. of Reading, Dept. of Agric. Econ. and Management, Dev. Study No. 12.

  Reviews a series of studies in South-East Ghana, designed to investigate existing agricultural practices and appraise the possibilities for change. The first chapter deals with the existing production environment and farming practices found. The second reviews the marketing framework which producers face, emphasizing maize, cassava, groundnut and oil palm products. Chapters 3 and 4 deal with suggested recommendations and the final chapter discusses the general nature of planning.

- WILSON, F.A., 1973, Some Economic Aspects of the Structure and Organisation of Small Scale Marketing Systems - Marketing of Fruits and Vegetables in Kenya. Inst. Dev. Stud., Nairobi, Discussion Paper No. 176, 25 pp.

2. Governmental

(i) Marketing Boards, Exports, Price Controls, etc.

- BAUER, U., 1969, Marketing Prospects - Tanzania. LA-UNDP/SF TAN/4, 56 pp. RESTRICTED.

- BERG, E., 1975, The Recent Economic Evolution of the Sahel, Centre for Res. on Economic Dev. for USAID.

- DOKU, E.V., 1969, Maize; Poor Storage, Distribution, Price Control. Ghana Farmer 13 (2) pp 61, 66.

- ETHIOPIAN TRADE (Special Issue), 1970, Agriculture, Industry and Trade in East Africa. Anon. pp 29-32 and 37-41, from Trop. Abst. 26 (2) pp 272.

  The article discusses development in agriculture, industry and trade in Ethiopia, Kenya, Tanzania and Uganda. The progress in output of the main export crops of the four countries (coffee, tea, cotton, sisal, groundnuts, sugar and maize) from 1962-1966 is discussed. Industrial activities and the structure of the export trade are also reviewed.

- FAO/UNDP, 1972, An Appraisal of Marketing Costs for Crops Handled by the National Agricultural Products Board for Use in Tanzania. Mktg. Dev. Bureau, Min. of Agric., Dar Es Salaam, FAO/UNDP Project SF TAN 27, Report No. 8.

- FAO/UNDP, 1972, A Review of the Production and Marketing Arrangements for Maize, Paddy, and Wheat with Particular Reference to the Milling Sector. Mktg. Dev. Bureau, Min. of Agric., Dar Es Salaam, FAO/UNDP Project SF TAN 27, Report No. 3.

- HELLEINER, G.H., Agricultural Export Pricing Strategy in Tanzania. ERB Paper No. 66.6.

- HELLEINER, G.H., Agricultural Marketing in Tanzania: Policies and Problems. ERB Paper No. 68.14.

- HENRIKSSON, R. ET AL, 1968, Food Grain Storage in Tanzania. Rep. prepared for the Tanzanian Gov't. Federation of Swedish Farmers Assoc., ADO 94 pp.

  The report is in two parts. The first part reviewed the present organisation of co-operative societies, unions and associations, the National Agricultural Products Board, and the larger milling facilities, (which have been nationalised under the Tanzania Millers Ltd., and get their supplies through the N.A.P.B.). Produce and market surplus figures are supplied and present storage facilities are reviewed by region for maize and wheat. Descriptions are given of current storage facilities, both local and regional and discussion of storage losses, pest control and quality are presented. Means, modes and organisation of transport facilities, price policies and costs of storage and handling are reviewed. In the second part, recommendations and proposals are presented covering each of the topics in the first part.

- ILORI, C.O., 1967, Towards a Policy of Marketing Improvement in Northern Nigeria. Bull. Rur. Econ. Social., Ibadan (2/3), pp 229-44.

  The article describes three ways in which the traditional marketing system for commodity foodstuffs can be improved; improving the physical structure of the market place, improvement in market facilities and establishing marketing extension services aimed principally at market middlemen.

- KARANI, H., 1965, Pricing and Marketing of Maize in Kenya. Inst. Dev. Std., Nairobi, Discussion Paper No. 19, 21 pp.

- KENYA, 1956, Export Maize Regulations, Kenya Official Gazette Suppl. No. 62, pp 662-9.

- KENYA, 1959, Maize Market (Ordinance). Kenya Legal Notice No. 355/1959, Ord. No. 6 of 1959.

- KENYA, 1959, Kenya Maize Regulations. Kenya Gazette Suppl. No. 7, (Legisl. supp. No. 5) Defence Reg. Ord.

- KENYA, 1959, Kenya Maize Price Controls - Kenya Gazette Suppl. No. 52 (Legisl. No. 31), pp 589-91.

- KENYA, Report of the Maize Marketing Board for July 31st 1961 ending.

- KRIESEL, H.C., LAURENT, C.K., HALPERN, C., and LANZELERE, H., June 1970, Agricultural Marketing in Tanzania. Background research and policy proposals. Michigan State Univ. Dept. of Agric. Econ. for USAID

  The study team was to make a comprehensive assessment of the existing marketing and pricing system and the organisation and management of the marketing boards and co-operatives and to make recommendations for their improved efficiency. The report gives a fairly detailed review of the agricultural marketing system in Tanzania. Each of the major agricultural products is controlled by a separate board. The major cereals (wheat, paddy, rice and maize) are handled by the National Agricultural Products Board. The Board purchases exclusively from co-operatives at uniform prices announced previous to the planting or marketing season. Internal sales are made at prices announced at the start of the season, but export prices are negotiated by the Board. Cereals such as millet and sorghum and beans, and peas, have, for short periods in the past, been handled by the National Agricultural Products Board, but in 1970, were handled in the free market. Because of its importance in the staple food and export markets, maize has come under marketing agency control since 1942. By 1965, virtually all maize was marketed exclusively through National Agricultural Products Board, through local co-operative societies. A detailed history of the growing control of government agencies over the maize market and present price determination procedures and the working operation of the National Agricultural Products Board is given. The Board's policy includes a grading system of four grades and a penalty for high moisture maize. The report evaluates the single channel marketing programme, its effects on price and supply stability, producers and consumers and on the marketing system. A separate section of the report deals with the co-operative societies and unions, isolating problem areas and offering proposals for solutions.

- LA ANYANE, S. & AFFUL, E.N., 1966, A Report on Guaranteed Prices for Maize. Univ. Ghana 16 pp.

  The authors feel that Ghana's maize industry does not need government protection or guarantees to develop. They note that maize prices fluctuate considerably due

to variations in supply. Recommendations are made for correcting the situation, including discussion of improved production, improved storage and credit, and improved transport and feeder road systems. They caution against instituting guaranteed prices.

- LAMADE, W.Z., 1966, Possibilities for a Marketing Policy for Maize in Ghana. Ausl. Landw. Frankfurt,a.M. 5 (3) pp 194-210.

  Discussion is presented on seasonal and yearly price fluctuations for maize between 1951 and 1964, along with regional price differences in 1964. Reasons for these price fluctuations are dealt with in detail. The author feels that market middlemen actually reduce price variations, contrary to popular opinion. He lists the reasons for setting up the Ghana Food Marketing Board, and what it hopes to achieve. A discussion follows on problems likely to arise in carrying out the marketing board's policy.

- LAMADE, W., The Role of Marketing Boards in Tanzania. ERB Paper No. 67.1.

- LIVINGSTONE, I., Production Price and Marketing Policy for Staple Foodstuffs. ERB Paper No. 71.16.

- MIRACLE, H.C., 1959, Economic Appraisal of Kenya Maize Control. East Afr. Economics Review, Vol. 6, No. 2.

- OLOYA, J.J., 1945-1962, Marketing Boards and Post-War Economic Development Policy in Uganda. India J. of Agric. Econ., Bombay. 23 (1) pp 50-8.

  The marketing boards' role in solving some of Uganda's economic problems during the post-war period are discussed. An evaluation is given of the boards' effectiveness in establishing pricing policies, price stabilisation and marketing regulations. Improvements are seen to be needed in allocation of government funds and in export taxation through marketing board profits.

- PURVIS, M.J., 1968, Agricultural Investment Opportunities with Limited Markets: The case of Yellow Maize in Western Nigeria, Mimeo, Nig. Inst. for Social and Econ. Research, Ibadan, Nigeria.

- RAIKES, P., 1968, Prospects for Exports of Tanzanian Agricultural Produce to Zambia. Econ. Res. Bur., Univ. College, Dar-es-Salaam, 43 pp.

  The existing and potential agricultural trade links between Tanzania and Zambia are examined, particularily Tanzanianexport of agricultural produce to Zambia. An examination is made of the problem areas in such a trade; (high transportation costs, import laws, relative purchase costs from various sources open to Zambia and the fact that many of the various crop seasons coincide). From a political viewpoint, it is felt that attempts should be made to overcome these problems.

- ROTHWELL, W.S., 1968, The National Agricultural Products Board, Tanganyika. Part 1: History, Composition and Functions. Trop. Stor. Prod. Info. (16), 17-21.

- SMITH, L.D., 1969, Resource Allocation, Income Redistribution and Agricultural Pricing Policies in Kenya. Inst. Dev. Stud., Discussion Paper No. 85, 15 pp.

- TEMU, P.E., Marketing Board Pricing and the Black Market: A Theoretical Analysis. ERB 71.1, Paper No. 67.2.

- UGANDA, 1954, Maize Marketing - Recommendations. Uganda Government Publication, 13 pp.

- YOSHIDA, M. & BELSHAW, D.G.R., 1966, The Introduction of the Trade Licensing System for Primary Products in East Africa. 1900-1939. Kampala: East Afr. Inst. Soc. Res., 29 pp.

  The study provides an analysis of the development and past performances of different market systems in East Africa, in an attempt to illuminate present problems. Specific subjects dealt with include: licencing traders and producers and produce marketing ordinances in Uganda, Tanzania and Zanzibar. In particular, the article deals with the problems that have arisen over licencing buyers. The authors feel that these marketing systems have eliminated independent middlemen and thus encouraged stagnation. The article deals with cash crops primarily, but could apply to maize as well.

(ii) Co-Operatives and Credit

- CHANT, J.F., Agricultural Credit in Tanzania. ERB, U. of Dar Es Salaam, Paper No. 68.4.

- UGANDA, 1954, Production Recommendations, re. Market Contracts for Sale and Co-operative Marketing. Ann. Rep., Dept. Co-op. Dev., Uganda, pp 14.

- WESTERGAARD, P., Primary Societies' Marketing Costs: A Case Study. ERB Paper No. 69.6.

F. Utilisation

1. Traditional Processing and Nutritional Assessment.

- AGBEDANA, E.O. & Taylor, G.O., 1975, The Supplementary Effect of Mineral Salts and Vitamins on the Growth of Rats.fed a Maize Starch "Ogi" Diet. Nut. Rep. Int., 11 (3), 251-255.

- AKINRELE, I.A., 1970, Fermentation-Maize. J. Sci. Fd. Agric., 21 (12) p 619.

- ANDAH, A. & MULLER, H.G., 1973, Koko Preparation and Chemistry. Ghana J. of Agric. 6 (2) p 1.

- ANKRAH, E.K., Undated, Maize Cooked Foods - Analysis, Ghana. Ghana J. of Agric. Sci. 51 pp 95-8.

- BASCOM, W.R., 1951, Yoruba Cooking. Africa, (Oxford).

- BASCOM, W.R., 1951 April, Yoruba Food. Africa, (Oxford).

- CHRISTIAN, W.F.K., 1970, Fermented Maize in Dough. Ghana J. of Sci. 10 (1), pp 22-28.

- DOH, 1971, Le Mais dans l'Alimentation Ouest-Africaine. En: Etudes Togolaises, Nouvelle Serie, Vol. 1, INRS, pp 39-75.

- FAO, Nutr. Div., 1948, Maize and Maize Diets. NU-N/N3/6, Dr, 10 pp.

- FAO, Nutr. Div., 1962, Surplus Food Programme. A Collection of local recipies for the use of cornmeal, beans and peas, wheat flour, milk and oil. 144 pp. RESTRICTED.

- GIBIRILA, B.O., 1969, Maize: Local Utilisation etc. J. Agric. Trop. Bot. Appl. 16 (9-10), pp 383-417 and (11-12) pp 495-528.

- MARTIN, A., 1963, The Marketing of Minor Crops in Uganda. D.T.C. Overseas Devl. Pub. No. 1, London, HMSO.

  Maize flour (posho) now plays an important part in the diet in most parts of Uganda, including the diet of the farmer. The consumption of maize flour will probably increase partly because of its palatability (as the c ommunity grows richer) and partly because of its ease of handling and preparation.

- MULLER, H.G., 1963, Ghanaian Kenkey. Food Trade Review 33 (10) 78 and Arkady Review, 48 (2) 32-39, 1971.

- OFOSU, A., 1971, Changes in the Levels of Niacin and Lysine during the Traditional Preparation of Kenkey from Maize Grain. Ghana. J. of Agric. 4 (2) pp 153-8.

  A description of various maize dough preparations used in Ghana is presented. Nine steps in the preparation of kenkey were defined and the niacin and lysine levels of the maize dough determined at each stage. Considerable protein was lost at the husking stage, but fermentation for 48 to 72 hours tended to increase the level. At the final stage, the food contained only 35% of the niacin and 40% of the lysine of the original grain. Two other dough foods were examined in the same manner and were found to result in 80-88% lysine and niacin loss.

- OKE, O.L., 1967, Chemical Studies on the Nigerian Foodstuff "Ogi". Fd. Tech. 21 pp 202-204.

- OVERSEAS REV. 1959, Maize Foods - Food Supplement for Africa.

- OYENUGA, V.A., 1959, Nigerian's Feeding-Stuffs, Their Composition and Nutritive Value. Ibadan Univ. Press, pp 35-8.

  A description is given of methods of preparing maize in Nigeria, including roasting and boiling the whole cob, cooking along with pulses, milling, and boiled as a porridge (ogi or eko). The nutritional value of U.S. and Nigerian maize is tabulated. Comparisons of composition of maize and other cereals are made.

- PAHUBY, C., 1965, Maize Use in Six Countries. For. Agric., U.S.A. 3 (45) pp 5.

- SCHLAGE, C., 1968, Polished versus Whole Maize: Some Nutritional and Economic Implications of the Traditional Processing of Maize. In: N.E. Tanzania. Res. Pap. Bur. Resource Assessment, Land Use Plan, Univ. Coll., Dar-es-Salaam, No. 2, 17 pp.

  Traditionally polished and fermented maize was chemically analysed to determine its loss of nutrients as compared with whole maize. It was found that 50% calories, 40% proteins, 88% fat and almost 100% vitamins and minerals were lost during the commonly used processing of maize. An economic assessment of this loss in terms of whole grain tonnages and of price loss is made.

- SCHWEIGERT, F., 1960, Preparation and Nutrition of Mahewu from Maize. J. Sc. Fd. Agric., 11 (7) pp 34.

- SENTI, F.R., & SCHAEFER, W.C., Maize Cooked Foods - Analysis, Ghana. Ghana J. Agric. Sci. 5 (2).

- SENTI, F.R. & SCHAEFER, W.C., Nov. 1972, Corn Uses - Worldwide. Cereal Sci. Today, pp 352-6.

- SKERMER, F.R., Autumn 1950, Different Products Based on Maize.

- TANZANIA, 1957, Food and Brewing. In: Ann. Rep., Dept. of Agric. for 1956, pp 16.

2. Modernized

(i) Milling

- ADELHELM, R. & Steck, K., 1973, Agricultural Machinery: A Guide to the Estimation of Costs. Min. of Agric. Nairobi, 29 pp.

- KENYA, 1966, Report of the Maize Commission of Inquiry. Gov't Rep. 1966, Storage, Milling, Industry, Etc., p. 633.15 (676.2).

- KENYA, Maize and Produce Board, 1969, Feasibility of Local Processing. In: Kenya Farmer (151) p. 10.

- UGANDA, 1954, Scheme for Uganda's Surplus Maize in Mills and Bakeries. New Commonwealth 27 (2) p. 88.

- ZAMBIA, 1966, Report of Zambia Min. of Agric., Monthly Econ. Bull, Sept. 1966, p. 32.

  Gives costs, expected life (hours), interest, depreciation, and repairs and spare parts costs for a hammer mill and a Slattery maize sheller.

(ii) Bread

- BALLSCHMIETER, H.M.B. & VLIETSTRA, H., 1963, The Use of Maizemeal in Fermented Wheat Breads (In German). Brot Geback 17 (3) pp 44-52.

- BALLSCHMIETER, H.M.B. & VLIETSTRA, H., 1965, The Use of Milled Maize Products in Making Bread with Wheat Flour. (In German) Brot Geback 19 (8) pp 153-158.

- BALLSCHMIETER, H.M.B. & VLIETSTRA, H., 1968, Yeasted White Loaf Containing 50% Maize (In German) Brot Geback 22 (4) pp 66-71.

- FAO, 1969, Joint Meeting of the Sub-Group on Food Processing Industries and Marketing, and the Ad Hoc Working Group on Utilisation of Agricultural By-Products. FAO/Industry Co-operative Programme, IP/AGS/AN G/69/14.

  Two processes for making composite flour bread using wheat extended with cassava or corn starch and supplemented with oil seed or other protein sources, were described by T.N.O. Wageningen and British Arkady Co. The Arkady process successfully made both open-tin and French-type bread, using up to 40% millet and sorghum flour. The T.N.O. process is reported to require calcium stearoyd-2-lactylate in the mixture. Nutritional studies have shown that composite flour breads to be equal or superior to conventional bread, nutritionally. Members at the meeting discussed the need for acceptability, marketing and economic feasibility studies, including: capital investment, operating and ingredient costs and potential savings of foreign exchange through substitution of imported wheat.

- FAO/UNDP, 1973, The Bread Study. Mktg. Dev. Bureau, Min. of Agric., Dar Es Salaam, FAO/UNDP Project SF TAN 27, Report No. 14.

- HOOVER, W.J., 1970, Research on High-Protein Breads. Paper Presented at the Sub-group Meeting on Food Industry and Marketing, 23 March.

  Currently, several countries have legislation regulating and requiring sorghum or cassava flours to be added to wheat flour in commercial milling at up to 10%. Work on improving the protein quality of bread through the admixture of soya protein at K.S.U., showed that coarse, granulated soya concentrate and use of high-speed dough mixing produced the best loaf. They also discovered that addition of sucrose esters to the dough mixture counteracted the deleterious effects of soya flour on bread quality up to 16%. Sodium stearoyl-2-lactate made soya flour functional at 12%. Tests using high lysine corn flours with wheat flours showed that the effective lysine content was not damaged in the mixture and up to 20% improved if high protein factions from a classified corn flour were used. The physical properties of the bread, however, allowed a maximum of 10% substitution before bread quality deteriorated.

- KIM, J.C. & RUITER, D. de, 1969, Bakery Products with Non-Wheat Flours. Bakers' Digest 43 (3) pp 58-63.

  Tests were done and formulae given for bread from cassava/soya flour, cassava/peanut flour, corn/soya flour and corn/cassava/soya flour. Because the dough lacked cohesive and elastic properties, the use of cake-making equipment was necessitated. Composite flours of wheat from wheat mixtures at high levels of non-wheat substitution using conventional bread-making equipment were tested.

- MADE, C., Van der, 1970, Bread from Composite Flours. Paper distributed to members of the sub-group meeting on food industries and marketing.

  The position of wheat and baking in Brazil is reviewed. Legislation makes the addition of 5% cassava starch to bread doughs mandatory to save on foreign currency. A report is presented on the past and present work being done in Brazil to evaluate different bread processing methods and additives. They found that for any composite flour, that the handling of any new mixture must be very similar to present methods and not result in higher capital or operating costs to the small bakers and that current levels of productivity and profits must be maintained,i.e. no increase in the retail price of bread. Tests done have shown that a good loaf can be made from 10% cassava flour, 5% cassava or maize starch and a medium strength wheat mixture, if 1% shortening or 0.3-0.5% C.S.L. is added.

- SOUTH AFRICAN BAKER MILLER, 1965, Some Notes on the Corn Loaf Approach. 33 (1) pp 5-6.

- SPRIGGS, E.I. & WEIR, A.B., 1971, The Digestibility of Bread made from Two Parts Wheat and One Part Oats, Barley, Maize or Rice. Lancet, Nov., pp 724-726.

(iii) New and Modified Uses

- ADEYINKA, O., 1968, Feasibility of Mechanised processing of "Instant Ogi" from Nigerian Cereals. Federal Inst. of Ind. Res., Oshodi, Res. Rep. No. 41.

  The report describes the pilot plant layouts and results of the plant trials to produce an "instant ogi", a traditional, fermented starch cake. The idea was to develop a process whereby this staple food would have a longer shelf-life than the one day, normal to the traditional product. This is followed by a discussion of the market situation, including raw material availability and the market potential of the product. The last section deals with a description of the process itself, discussion on possible plant locations and fairly detailed production economics analysis.

- ANTONIO, Q.B.O., Food Consumption and Income Relationships in Nigeria: Engels Curve Function. Bull Rur. Econ. Social, Ibadan. 2 (1) pp 52-67.

Income elasticities for different classes of food (.429 for staples) and for overall food consumption are derived. About 60% of monthly income goes for food, on the average. The author discusses the implications of various food prices for industrial development.

- BOOKWALTER, G. ET AL, 1968, Storage Stability of Blended Food Products; Formula No. 2, a Corn-Soy-Milk Food Supplement. Food Technol. 22 (12) pp 1581-84.

The storage stability of C.S.M., a high-protein supplement for pre-school children, consisting of partly gelatinised corn meal, toasted soy flour and non-fat dry milk, and fortified with minerals and vitamins, was tested. Commercial and laboratory formulae mixtures were tested at 77°, 100°, and 120°F. in sealed containers. At approximately 10% moisture, samples maintained adequate stability for 365 days at 77°F., 6 months at 100°F., and 8 weeks at 120°F. C.S.M. was more stable when held at 5% moisture content under the same conditions, except peroxide values of the extracted fat increased. At 13% moisture content, C.S.M. was less stable as measured by tests for flavour, vitamin A, thiamine, available lysine and free fatty acids in extracted fats.

- CANTOR, S.M. & ROBERTS, H.J., 1967, Improvements in Protein Quality in Corn-Based Foods. Cereal Sci. Today, 12, pp 443-455 and 460-462.

- CHADHA, Y.R., 1962, Starch Products from Maize. Trop. Sci. 4 (1) 13.

- COLLINS, P.B., 1969, Instant Ogi, West Africa, p. 1410.

A short discussion is presented on the outcome of a Federal Institute of Industrial Research project in Nigeria to develop an instant form of the traditional fermented starch cake "ogi"made from millet, sorghum and maize. The purpose was to extend the shelf life to 3 months from one day, in order to help stabilize the supplies of this staple. A schematic view of the process is given, along with a discussion of the comparative cost of the cellophane packaged product with its counterpart in the market and a simple breakdown of operational costs and benefits. The article ends with a discussion on possible sites for the location of these processing plants.

- DIMLER, R.J., 1967, Soybeans and Corn Join Forces in Food. Soybeans Digest 27 pp 50-53.

- DINA, J.A. & AKINRELE, I.A., 1970, An Economic Feasibility Study for the Establishment of a Glucose Industry in Nigeria. Tech. Mem., Fed. Inst. Indus. Res., Fed. Rep. of Nigeria, 25 pp 1-28.

The report gives an extensive cost estimate for establishing and operating a glucose industry capable of producing 3,000 tons of liquid glucose or 1500 tons of glucose crystals per year from either cassava or maize starch. The study indicates that only cassava starch used to produce liquid glucose would be feasible.

- ING, G. (ed.)., Corn; Culture, Processing, Products.

- IRAT, Qualité du Mais et Industrie.

- KAPLINSKY, R., 1974, Choice of Technology in the Kenyan Food Processing Sector, with Particular Reference to the Situation and Orientation of Technical Change: A Project Outline. Inst. Dev. Stud. Working Paper No. 202, 19 pp.

- KENYA, 1958, The Maize Industry. Sessional paper No. 6 of 1957-58, Nairobi.

- KENYA FARMER, Feb. 1970, Acceptance Study, Maizemeal (Enriched). No. 162.

- MILLING, 1961, Enriched Maize Cereal., 136 (24) 644.

- MULLER, H.G., 1968, Enrichment of Ogi. Food Manufacturer 43 (9) pp 44.

- MULLER, H.G., 1968, Australian Food Manufacturer, 37 (12) p 20.

- NIGERIA, 1967, Federal Institute of Industrial Research, Oshodi, Protein Enrichment of Maize in Nigeria. Quarterly Progress Rep., Apr.-June, p. 7.

- NIGERIA, 1967, Federal Institute of Industrial Research, Oshodi, Quality Test, Soy-Ogi. Quarterly Progress Rep., Oct.-Dec., p. 9.

- ROZSA, T., 1966, A Commercial Process for Producing a New Low-Protein, High-Starch Flour Product. Food Tech. 20 (4) p. 152.

- TOLLEFSON, B. Jr., 1967, New Milled Corn Products, Including C.S.M. Cereal Sci. Today 12 (438), pp 440-441.

- WIE HAN KWEE, ET AL, 1969, Quality and Nutritive Value of Pasta from Rice, Corn, Soya and Tapioca, enriched with Fish Protein Concentrate. Cereal Chem. 46 (1) pp 78-84.

(iv) Packaging

- ETUDIE D'OUTRE MER, 1956, Packing Requirements for Maize in French Colonies. (39) pp 370.

- HANOUSEK, J., 1969, Protective Packaging of Rice under Malaysian Climatic Conditions. Food Tech. Res. and Development Centre of Malaysia, FAO, 24 pp.

The type of packaging material depends on the moisture content of the rice to be packaged and the length of time it is expected to be in store. Permeability to water vapour is the main criterion for choosing a packing material. These values are calculated for various types and thickness of packaging materials. Effective surface of the package itself is also important, so that package dimensions should be chosen to give the least effective

surface. Recommendations are made for the rice industry on the proper packaging techniques and materials for various climatic and storage conditions and also on long term storage of paddy in jute sacks under some type of waterproof sheet, based on the same principles. Throughout , the principle that all seals be airtight is emphasized.

- JOHNSTON, R.M., GREENWAY, W.T. & HARTSING, T.F., 1972, Evaluation of Paper, Cotton and Polythene-film Bags for Packaging Cornmeal. U.S. Agricultural Research Service, Washington.

  The study was conducted to determine the relative effectiveness for storing degermed cornmeal, of paper, cotton, and polythene-film bags. 3 and 50 lb. samples in each type of container were stored for 24 weeks under control, ambient and high humidity conditions. Moisture level, fatty acid and fat content changes were measured over the period and taste and smell tests performed to gauge the relative effectiveness. Plastic bags proved to be adequate storage containers under all storage conditions, whereas cotton and paper containers were only adequate under the control conditions, i.e. 73°F. and 50% relative humidity.

3. Animal Feeds

- DENDY, D.A.V., 1969, Furfural from Agricultural Waste Available in East Africa. East Afr. Agric. For. J. 34 (4) 433-5.

  The production, characteristics and uses of furfural from pentosans found in most plants including sugar cane, bagasse, cotton seed, maize cobs, rice hulls and coffee parchment, are briefly described, along with the potential yield from each of these waste products. The author believes bagasse to be the most promising material.

- FAO/UNDP, 1973, A Review of the Supply of Raw Materials for the Manufacture of Animal Feeds. Mktg. Dev. Bureau, Min. of Agric., Dar Es Salaam, FAO/UNDP Project SF TAN 27, Report No. 24.

- ORANYELI, C.O., 1966, Supplementing Groundnut Cake with Maize Dusa. Nigerian Agric. J. 2 (1) pp 39-43.

G. Extension and Training Aspects of Post-Harvest Technology

- ASCROFT, J., ET AL, 1972, An Overall Evaluation of the Special Rural Development Programme. Inst. Dev. Stud., Nairobi, Occasional Paper No. 8, 310 pp.

- BROWN, C.K., Undated, Some Problems of Investment and Innovation Confronting the Ghanaian Food Crop Farmer. Univ. Ghana, Inst. Stats. Soc. Econ. Res., Tech. Publ. Service, No. 24.

  The report discusses problems of and obstacles to promoting innovation and entrepreneurship among food crop farmers with emphasis on credit and extension services. It also makes recommendations on overcoming the problems. The report includes a history of agricultural credit (past and present) and extension work, storage and marketing surveys, marketing and co-operatives.

- COYNE, F.P., March 1970, Improving Farm Storage of Maize, (General Principles and Their Application to Small Farms). Kenya Min. Agric., Duplicate booklet, 38 pp.

  The booklet was written to aid extension officers in improving grain storage (especially maize) on small farms. It includes: brief mention of insects and their environment, the maize weevil and the damage caused(loss figures given); field attack of growing maize; outline of control measures; how to stop weevil damage; crib cleaning; crib spraying (green circle spraying); treatment of cobs (red triangle dust); treatment of shelled maize (blue cross dust); directions for use of fuffle; economics of control measures; storage without cribs (in trees, on poles, in cooking pot over the fire); and pilot schemes (functions, planning, operation). Three appendices contain background information considered necessary for extension officers: insect pests of stored grain, insecticides, (types, safety in use, insect resistance) and construction of cribs(special reference to rat-proofing.

- COYNE, F.P., 1971, Improving the Protection of Stored Maize from Insect Attack on Small Farms in Kenya. Int. Pest Control 13 (3) pp 8-13.

  Description of operations to improve maize storage on Kenyan small farms, in the Western Province, where losses were estimated at 50%, mostly from weevils, both in the field and in store. Training courses for district agricultural officers and farmers were financed by the U.K. Freedom from Hunger Campaign Committee to teach storage hygiene and weevil control. 400 farms around Bukura were chosen and demonstrations set up. Over the 3-month period, between 6 and 9 months after harvest, the demonstration units had 17%, 15% and 18% less loss to weevils than the untreated areas around them.

- MACKAY, P.J., 1973, Marketing and Storage Development Project, Uganda. FAO Informal Tech. Rep., A.G.S: U.G.A. 71/513, 34 pp.

- MUTHEE, A.M., 1973, Agricultural Marketing Training in Kenya. Dept. of Agric. Econ., Fac. of Agric., U. of Nairobi.

- SCHULTEN, G.G.M. & WESTWOOD, D., 1972, Grain Storage Project Malawi. Min. of Agric., Malawi Agric. Dev. and Mkt. Corp. and Chancellor College, Univ. of Malawi.

  Contains three reports. The first one is mainly on administrative matters of the project. Report 2 deals with extension work. It gives a summary of courses given and a list of the extension leaflets prepared and distributed. A detailed description of the construction of a traditional village grain store and an account of the search for improved grain store designs are given. Other storage methods discussed include: hermetic storage in drums and in thick plastic bags and in-bag fumigation. There are brief notes on a storage survey, use of "fuffle" and maize shellers, rodent control and cultivation of bamboo and other materials for improved construction methods. Report 3 reviews the research projects. A series of trials were done to determine the effectiveness of lindane, pyrethrum/carbaryl and piriniphos-methyl for protecting ear maize. Various insecticides were used to test the effectiveness of improved mud bins and bags for protecting shelled maize. Effectiveness of various insecticides were also tested for beans, cowpeas and chickpeas.

- WESTLEY, S.B. ET AL, 1975, A Food and Nutrition Strategy for Kenya, Summary Report of a Workshop. Occasional Paper No. 14, Inst. Dev. Stud., Nairobi, 40 pp.

IV. COWPEAS AND OTHERS

A. Post-Harvest Systems

- AFRIKA HEUTE, 1969, Teff im Aethiopien. 9, 135-7.

  Teff is used only as a food crop in Ethiopia. Harvesting can take place anywhere between 2 and 6 months after sowing, due to varietal differences. Cultivation, harvesting and threshing are discussed. Diseases and insects cause only a very slight problem. The method of preparing "njera", a flat, round, slightly sour bread made from teff flour, is described and a lengthy discussion of the nutritive value of teff is given.

- GHANA FARMER, 1967, Increasing the Production of Protein Foods: The Lima Bean (Phaseolus). 11 (4) pp 152.

  A short description of the cultural practices for the lima bean is given. The optimum stages for harvesting the bean, depending on the further method of processing, is discussed, followed by a description of a successful storage technique. Field pests are outlined. The problem of cyanic acid content in the bean and methods of overcoming it by grating or milling and soaking in hot water are discussed. White beans appear to be more palatable than dark ones.

- KURANCHIE, P.A., 1974, Cowpea Production and Marketing in Ghana. Food Research Institute, Accra. Paper presented at the Cowpea Utilisation Conference held at Senegal in June 1974, 14 pp.

  This paper presents a brief overview of cowpea production, movement and marketing in Ghana. The first sections cover the distribution of cowpea production, yields, and reasons for low yields. Harvesting and threshing are always done by hand, usually at least 4 times a season as the cowpeas ripen unevenly. Storage methods and lengths of periods of storage are discussed. Most farmers sell the majority of their cowpea crop (67% average). The movements of cowpeas from the primary producing area, in the north, to the south and the various marketing channels through which they travel are outlined. Two types of wholesalers are identified, the first, who purchases and transports the beans to the major centres, and the second, who depends for his supply on the first and operates only in one centre.

- LEPIGRE, M., 1965, Etudé sur les Possibilitées d'Amelioration de la Conservation des Haricots au Togo en Milieu. L'agron. Tropical 20 (4) pp 358-430.

  Lists of time of harvest of beans from various regions of Togo are given. Most regions store beans in the pod in ventilated granaries, which allow for drying. Beans are shelled before selling. Up to 30-40% of beans are found damaged by insects. Rarely the beans are washed and dried before marketing to remove the ash in which they have been stored. Descriptions of types of insect damage and their life cycles are given. Traditional methods of storage are described and reasons for low marketing prices outlined. Improved methods of fumigation techniques are also covered.

- MAESEN, L.T.G. van der, 1972, Meded. Land. Hoogesch., Wageningen. 72 (10) pp 1-342.

  Contains a section (pp 253-59) on the insects that attack chickpeas as a growing crop and as the stored product. Also, details of production, trade, commercial grades and notes on cultivation, harvesting, grading and storage.

- TINDALL, H.D. & WARSTER, R.T. (ed.) 1971, First East African Horticultural Symposium. Maherene University, Kampala, Uganda. 23-24 February 1970, The Hague. International Society for Horticultural Science, Acta Horticulturae; Technical Communications 21, 212 pp.

  Thirty-five papers were presented concerning the role of horticultural crops in the diversification of agriculture in East Africa. Some of the topics covered included: regional use of horticultural crops, exports to temperate zones, marketing problems, phytosanitary problems and plant quarantine. The horticultural crops dealt with included pulses.

B. Harvesting and Conditioning

(i) Traditional

- CHAD, 1969, Present Practices in Collecting Produce among the Zaghawa of Chad. J. of Agricultural and Tropical Botany, 16 (2-3-4-5) pp 55-83, TPI Translation.

  A general article on the collection of cereals, berries and wild fruits etc. and local customs (including storage).

- SAVILE, A.H. & WRIGHT, W.A., 1958, Notes on Kenya Agriculture, III. Oil seeds, Pulses, Legumes and Root Crops. East Afr. Agric. J. 24 (1) 1-9.

  Very short notes on the climate and soils, cultivation, harvesting and major uses of a large number of crops grown in Kenya, including: sword bean, jack bean, velvet bean, chickpea, peas, pigeon peas, and green and black grams.

(ii) Improved

- INTERMEDIATE TECHNOLOGY DEVELOPMENT GROUP LIMITED, 1973, Guide to hand-operated and animal-drawn equipment. London, 82 pp.

  Brief descriptions or illustrations of various hand or animal operated tools for use primarily in developing countries. The equipment is listed under one of eight sections which include: harvesting, threshing and cleaning, and crop processing.

- OUBRECHT, J., 1967, Technological Procedures in the Cultivation of Teff. Beitr. Trop. Subtrop. Landwirtsch U. Tropenveter - Med. 5 (1) pp 15-21.

  The article deals with the possibilities of mechanising the various operations in the cultivation of teff. The traditional practices are described. The author feels that because of the climatic and topographical conditions sowing, weeding and harvesting should be done by hand. Mechanical threshing appears to be feasible, though. He discusses the features of a small automatic threshing machine driven from a power take-off unit.

- ROBERTSON, J.K., 1955, The Growing of Canning Beans in Tanganyika. World Crops 7 (1) pp 23-25.

  A short history of white haricot beans for export from Tanganyika is given. Most of the beans are grown by white farmers and the cultivation is considerably mechanised. Descriptions of the culture and pests and diseases are given. Harvesting of large fields is best done by all-crop harvestors, whereas small fields are handled better by wind-rowing and combining. This should be done when the humidity is relatively high. A general discussion of seed cleaning and fumigation against insect infestation follows. Export figures are given along with a discussion of future possibilities for the crop.

C. General and Farm Storage

(i) Traditional

- EZEDINMA, F.O.C., 1961, Research on Cowpeas in Nigeria before 1960. Mem. Fed. Dept. Agric. Res. Nigeria, No. 68.

  Traditional methods of storing cowpeas in earthenware pots with red peppers is described. An account is given of various early attempts at improved cowpea storage and fumigation, with comparisons of their effectiveness to traditional methods, and an assessment of their adaptability for large scale storage. Common insect pests are listed and an estimate of the amount of national loss from infestation is given.

- GILES, P.H., 1963, Cowpea Storage by Northern Nigerian Farmers. Proc. First Nig. Agric. Legume Conf., Samaru.

  Descriptions of traditional methods of cowpea storage are given, storage insects are listed and examples are given of the amount of damage done at various times of the year. Results of storage research on lindane dust for use on millet and sorghum in granaries are noted and preliminary results of similar treatments for cowpeas are discussed.

- INSTITUTE FOR AGRICULTURAL RESEARCH, Samaru, Nigeria, Ann. Report 1965-66, Storage of Cowpeas by Farmers, pp 42-3.

  Preliminary study of 29 replies to a questionnaire directed to farmers was analysed. It showed that harvest of cowpeas is spread over 3 months, beginning in November in the North and January in the South. It is more common to store beans in the pod. Across the middle of the North, storage in mud granaries is the most common method. Some mud granaries are used to the North and South of this region, but more commonly, grass granaries are used. Insecticides are never used, but sand or ashes are mixed in frequently. Farmers store up to a ton of cowpeas, disposing of approximately half of it to middlemen in local markets within three to six months of harvest.

- I.A.R., 1969, Protection Afforded by the Cowpea Shell and Protection of stored Cowpeas by Chemicals. Samaru. Ann. Rep. 1966-67, p. 45.

  Cowpeas from the same source were stored with and without the shell for 8 months. In shell, damage was 32%, while shelled pea damage was 87%. Also, unshelled cowpeas in 12 grass and mud stores in different areas were treated with 0.5% gamma BHC dust at 15 parts per million, and stored for 3 to 6 months. Some protection was afforded in mud stores at three months, but no protection after 6 months. In grass stores no protection was afforded at all.

2. Storage Losses

- APPERT, J., 1964, Faune Parasitaire du Niebe en Republique du Sénégal. L'agron. Trop. 19 (10) pp 788-99.

  The article describes the insects which damage cowpeas in the field and in storage, when the damage occurs, and to what extent. Brief mention is made of the importance of quality control before organised marketing and price control can be introduced. The author assesses a number of fumigation and storage techniques, both traditional and improved, being used in Nigeria, Ghana and Senegal.

- DAVIES, J.C., 1961, Pulses. Letter ex Kawanda Research Station, Kampala, Uganda. - Reply to questionnaire from Dr. Halls.

- KADKOL, S.B., PINGALE, S.V., SWAMINATHAN, M., 1956, Effect of Insect Infestation on Stored Bengal Gram and Green Gram. Food Science 5 (9) p. 211.

  The study investigated the changes in weight, viability, free fatty acids and thiamine content of green and Bengal grams, infested with Bruchus chinensis (L.) in storage. Significant loss of weight and viability did occur and there was a small amount of denaturisation of protein, reduction in th mine and increase in fatty acidity. Experimental procedures are explained.

- RILEY, J., 1963, The storage of Cowpeas in Nigeria. Proc. First Nigerian Grain Legumes Conf., Samaru.

  The time, place and spread of cowpea infestation is described. Maximum and minimum damage levels in the field and in Lagos market are listed. A value is placed on the loss of foodstuffs from infestation and methods of reducing pre-harvest infestation and storage damage by using sand in rumbus, and other containers, are given.

- VENKAT, Rao S., NUGGEHALLI, R.N., SWAMINATHAN, M., PINGALE, S.V., & SUBRAHMANYAN, 1960, Effect of Insect Infestation on Stored Field Bean (Dohchos lablab), and black gram (Phaseolus mungo). Food Science 9 (3) pp.79-82.

- WILKIN, F.J.E., 1964, Pulse Survey. Rep. Trop. Stor. Prod Centre.

  The major emphasis of the survey of 12 African countries was to collect information on losses to stored pulses from insects. Main headings include: source of information and samples, examination of samples, moisture content determination, estimation of bruchial damage by weight and by number of holes, factors affecting the level of bruchial damage, including lengths of storage period, resistance, storage conditions, relation between visible and hidden bruchia damage, occurrence of bruchial species, non-bruchial damage and mould damage.

3. Factors Affecting Storage

(i) Biological

- BOOKER, R.H., 1962, Northern Nigeria, Min. of Agric., Ann. Rep. (Research and Specialist Services) p. 23.

  The paper reports that infestation by the major storage pest of cowpeas, Callosobruchus maculatus, begins in the field, but is at a very low level, less than 1% of seeds being attacked. This level, however, is sufficient to start store infestation and cause weight losses of 45% after 3 months storage. Indications are that spraying can reduce the level of pre-harvest infestation. Two other bruchids, Bruchidius atrolineatus (the most common bruchid in the field) and Callosobruchus rhodesianus occur commonly in the field, but do not persist long in stores. The author states that the general pest complex associated with cowpeas is also found on most other legumes. It was found that Sevin insecticide effectively controlled an attack of Phaseolus aureus by Ootheca mutabilis.

- BOOKER, R.H., 1965, List of Insect Species found in Association with Cowpeas at Samaru. Samaru Misc. Paper No. 9, Institute for Agric. Research, Nigeria.

- BOOKER, R.H., 1967, Observations on Three Bruchids Associated with Cowpeas in Northern Nigeria. J. Stor. Prod. Res. Inst., 3 pp 1-15.

- CASWELL, G.H., 1961, The Infestation of Cowpeas in the Western Region of Nigeria. Reprinted from Topical Science, Vol. III, No. 4.

- CASWELL, G.H., 1956, Observations on the Biology of Callosobruchus maculatus F. (Coleoptera, Bruchid), 6th CIAO Conference, Sao Thome, Aug. 1956.

- CASWELL, G.H., 1960, Observations on an Abnormal Form of Callosobruchus maculatus (F), Bull. Ent. Res. 50, 671-80.

- DOBIE, P., 1973, The Susceptibility of Cowpeas to Infestation by C. maculatus. Trop. Stor. Prod. Centre Rep.

- HABISH, H.A., 1972, Aflatoxin in Haricot Beans and Other Pulses. Khartoum Exper. Agric. 8 (2) 135-7.

  A study with haricot beans and other pulses in the Sudan indicated that 41 out of 74 samples showed the presence of aflatoxins and the fungus aspergillus flavis. The highest levels of contamination came from samples of stored seeds, whereas freshly harvested beans were only lightly affected. There appeared to be some correlation between the presence of the fungus and the toxin level. The data indicates that toxins are produced after harvest so that careful crop drying and cutting of moulded pods before storage is recommended.

- HOPKINS, J.C.F. & PEARSON, E.O., Nov. 1961, Report on Visit to West Africa.

  Studies on preharvest insect damage to cowpeas and the degree of transfer to stored cowpeas are reported.

- HOWE, R.W. & CURRIE, J.E., 1964, Some Laboratory Observations on the Rates of Development, Mortality and Oviposition of Several Bruchidae Breeding in Stored Pulses. Bull. Ent. Res. 55 (3) 437-477.

- INSTITUTE FOR AGRICULTURAL RESEARCH, Ann. Rep. Samaru, Nigeria, 1962-63, pp 31-32.

  Ways of reducing pre-harvest infestation are discussed. The biology (including the life cycle) of cowpea insect pests are reported and the major species identified along with their infestation characteristics.

- PREVETT, P.F., 1961, Field Infestation of Cowpea (Vigna unguiculata) Pods by Beetles of the Families Bruchidae and C. urculionidae in Northern Nigeria. Bull. Ent. Res., 52 (4) 35-45.

- PREVETT, P.F., 1965, The Genus Caryedon in Northern Nigeria with Descriptions of Six New Species (Col. Bruchidae). Ann. Soc. Ent. Fr., (N.S.) 1 (3) 523-47.

- PREVETT, P.F., 1966, Observations on the Biology of Six Species of Bruchidae (Coleoptera) in Northern Nigeria. Ent. Mon. mag. 102 (1226-1228) 174-180.

- PREVETT, P.F., 1967, Notes on the Biology, Food Plants and Distribution of Nigerian Bruchidae (Coleoptera) with Particular Reference to the Northern Region. Bull. Ent. Soc., Nigeria, 1 (1) 3-6.

- TAYLOR, T.A., 1963, The Field Pests Problem on Cowpeas in Southern Nigeria. Proc. First Nigerian Grain Legumes Conf., Samaru, p. 3.4.

  A common pest of mature and drying pods is Laspeyresia ptychoca. It seems doubtful whether this pest could ever become a storage pest; however, the seeds lose weight as a result of infestation, contamination by the frass inside the pod occurs and the cost of separating damaged seeds and frass from whole seeds lowers the marketability and value of the cowpea.

- TAYLOR, T.A., 1974, On the Population Dynamics of Taeniothrips Sjostedti (Tryb.) Thysanoptera, Thripidae) a Major Pest on Cowpea and an Alternative Host, Centrosema Pubescens Benth., in Nigeria. Rev. Zool. Afr. 88 (4) 689-702.

- THOMSON, A.G., 1953, Protection of Stored Foods. New Commonwealth 26 (6) p. 296.

  The article is particularily concerned with rice, groundnuts, peas and beans, grown in Africa and shipped to the United Kingdom. The author gives a general description of the common pests of each of these foods, their life cycle, and how they damage the seeds and when. He notes that many of the pests can cross-infest from the field into storage areas and vice versa, and also from one grain to another during shipment.

(ii) Environmental

- ADESUYI, S.A., 1970, The Relationship Between Relative Humidity and Moisture Content of Some Nigerian Foodstuffs. Rep., Nat. Stor. Prod. Res. Inst., Tech. Rep. No. 8, pp 61-65.

  Using saturated salt solution at 25°C, relative humidities were maintained in dessicators to determine the moisture content-relative humidity equilibria of brown and white cowpea and yam flour. The moisture content equilibrium with 70% relative humidity was considered safe for storage. It was determined to be 13.5% for brown cowpeas, 13.3% for white cowpeas, and 15.8% for yam flour.

- DAVEY, P.M. & ELCOATE, S., 1967, Moisture Content/Relative Humidity Equilibria of Tropical Stored Produce (Part 3: Legumes, Spices and Beverages). Trop. Stor. Prod. Info. 13, P. 15.

  Information from the literature is used to draw up a generalised moisture content/relative humidity equilibrium curve for each of:

  1) pulses: beans (Phaseolus vulgaris), peas and soya beans;
  2) spices;
  3) coffee and cocoa beans.

- OKWELOGU, T.N., 1969, Maximum Safe Moisture Content for Storing Teff (Eragrostis abyssinica, Schrad), and Sarawak Illipe Nut (Shorea gysbertsiana, Burck). J. Stor. Prod. Res. 5 (2) 169-172.

  The equilibrium moisture content of cereals and oilseeds at 70% relative humidity is generally considered the safe maximum level in order to avoid microbial deterioration of the crop in store. This paper deals with determining the equilibrium moisture content of teff and Illipe nuts. Details of the experimental procedure are given. The results showed the maximum safe moisture content of teff as 14.2% for drying grain and 13.5% for grain taking up moisture.

- TROPICAL STORED PRODUCTS CENTRE, 1973, Safe Moisture Contents of Chick Peas. Structures and Handling Section, Trop. Stor. Prod. Info. (23), 10-11.

4. Storage Research and Improvement

(i) General

- AHETO-TSEGAH, G.C., 1975, Improved Methods of Storage of Cowpea (Vigna Unguiculata) in Jute Sack. Fac. of Agric., U. of Kumasi, Ghana 76 pp., Unpublished.

- AKPAETAK, O.I., 1974, Drying and Storage of Cowpeas with Ashes in Air-tight Containers. J. Agric. Eng. Res. 19, 279-287.

- AYOADE, K.A., 1974, Evaluation of DDT Schedules for the Control of Pod Borer, Maruca Testulalis Gey, Infestation on Cowpea (Vigna Unguiculata (L.) Walp), Var. "Mala." Niger. J. Entomol. 1 (1) 9-12.

- BOOKER, R.H., 1965, Pests of Cowpeas and their Control in Northern Nigeria. Bull. Ent. Res. 55 (4) 663-672.

- CASWELL, G.H. & CLIFFORD, H.T., 1958, Effect of Fumigation and Moisture Content on the Seedling Growth of Cowpea (Vigna unquiculata). Nature 182 540-1.

- CASWELL, G.H., 1961, The Infestation of Cowpeas in the Western Region of Nigeria. Trop. Sci., 3 154-8.

- CASWELL, G.H., 1968, The Storage of Cowpeas in the Northern States of Nigeria. Samaru Res. Bull. 120, Reprint, Proc. Agric. Soc., Nigeria (5), July p. 2-6.

  Describes a method of estimating losses of stored cowpeas and gives estimates of gross monthly losses for the region. For a total crop of approximately 1,000,000 tons, the calculated loss is 24,000 tons. The most important insect pest is Callosobruchus maculatus. Storage in the pod gives considerable protection to the seeds. On tests of chemical control methods, BHC proved unreliable; Phostoxin at the rate of 10 tablets per ton in a concrete silo gave complete control. The use of airtight storage is discussed.

- CASWELL, G.H., 1971, The Storage of Cowpeas. Cowpea meeting 27-28 Sept. 1971. Mimeo. paper, 5 pp.

- CASWELL, G.H., 1973, The Storage of Cowpeas. Samaru Agric. Newsletter, 15 (2) 73-75.

- CHOUDHURI, H.C., 1963, Breeding of Grain Legumes - Cowpea in Nigeria. Proc. 1st Grain Leg. Conf., Samaru.

  Reports the estimated loss from C. maculatus in storage to be as much as 10% dry weight after 6 months. Describes improved techniques of storage in oil drums, fumigants and the use of CO_2.

- DAVIES, J.C., 1959, A Note on the Control of Bean Pests in Uganda. East Afr. Agric. J. 24 (3) 174-178.

- GILES, P.H., 1961-62, Northern Nigeria Min. of Agric., Ann. Rep. pp 23-24.

  A comparison is reported between storage trials with untreated, unshelled cowpeas in mud rumbus or earthenware pots and pods dusted with 10 ppm lindane as a sandwich treatment over a 12-month period. The 30% damage level from Bruchids was considerably reduced with the lindane treatment.

- HART, J.R., 1970, A Flotation Method for Determining Extent of Weevil Infestation in Peas. J. Econ. Ent. 64 (4) 1060.

  Pease damaged by the pea weevil Bruchus pisorum have a lower density than undamaged peas. Damaged peas may be removed from a sample by flotation in a salt solution containing 300 g. of NaCl/litre H_2O. It then becomes necessary, in determining extent of damage, to examine individually only those peas which have floated. Soaking floated peas in water facilitates detection of weevil entrance holes.

- HASHIDU, A.H., 1974, Cowpea Storage Trials in the North-Eastern State of Nigeria. Interim Rep. presented at the Cowpea Utilisation Conference, Dakar, Senegal, June 1974, 4 pp.

- HAYWARD, L.A.W., 1964, The Storage and Quality of Grain Legumes in West Africa. Appendix "C" from rep. of FAO Plant Production and Protection Div., Rome 1964.

  The report states that grain legumes take on great importance where animal protein is unavailable and expensive, especially since the discovery of aflatoxins in groundnuts. Figures are given for production of grain legumes in West African countries, along with examples of losses from infestation. The author believes that infestation of grain legumes often begins in the field, but that most damage is done during storage, and further, that these pests are relatively easy to control if measures are taken immediately after harvest. Short descriptions of traditional storage methods are given. Note is taken of a method involving fumigation of beans with ethylene dibromide and sealing in polythene bags introduced by Rawnsley to Ghanaian traders. Suggestions for improved marketing and storage systems are made.

- HURLOCK, E.T., 1963, Detection of Insects in Dried Peas: X-ray Shows Most Promise Among 8 Methods. Food Manufacturer 38 (7) pp 367-9.

  Public health authorities and food processors require simple and quick methods of detecting hidden infestation in cereals and pulses. Most of the simple methods used in the past have been developed for cereals, few for pulses. This study was an attempt to see if some of the methods used on cereals could also be applied to pulses. The various methods resulting were compared for reliability and accuracy. The X-ray method seems best to meet these criteria.

- I.A.R., 1971, Rep. to the Board of Gov. on Inst. for Agric. Research work in 1970. Samaru, Zaria, Nigeria.

  Report of the storage trials on cowpeas are given. Includes: damage under traditional conditions, lists of effective insecticides, tests of various plastic bag sizes and gauges, plastic silos and locally made semi-permanent silos, and their results.

- MARTIN, A., 1963, The Marketing of Minor Crops in Uganda. D.T.C. Overseas Research Pub. No. 1, p. 8.

  The report states that weevil attacks on beans in store is a serious problem and recommends insecticidal use. Also recommended is a subsidy on insecticides for storage. Field peas are used in some areas as the major famine food reserve, due to its good storage qualities. Beans and cowpeas are very susceptible to weevil attack in store. Also, green grams store better than beans. Because they ripen unevenly, often more than one harvesting is needed.

- NIGERIA, 1964, Min. of Agric. and Natural Resources, Moor Plantation, n./dc. Note on fumigating seed for storage using phostoxin.

  Describes tests with phostoxin on cowpeas in store to control bruchids. All stages of the insect were killed and viability of the seed was unimpaired. Small trials, using sealed plastic bags with phostoxin, including: paper bags, envelopes, jars and bottles. After 48 hrs., 100% insect kill was observed. Germination percentages were within the normal range after treatment.

- OPUTA, C.O., 1962, WASPRU/UCI, Grain Storage Project 5. Cowpea storage in a concrete bin. WASPRU Ann. Rep. pp 91-4.

  Cowpeas were put into a clean concrete bin in February 1962. It was fumigated with ethylene dichloride and CCL_4, and later with phostoxin as the first mixture was not effective. Reinfestation occurred in July and phostoxin was again applied. Methods of fumigation are detailed. Taste tests on the treated grain gave no indication of changes of palatability. Results of damage assessment are given. It is recommended that cowpeas be fumigated with phostoxin on loading into the store to avoid a build-up of infestation.

- POINTEL, J.S., 1967, Etudes et Travaux. Contribution à la Conservation du Niebe. L'Agron. Trop. 22 (10), pp 925-32.

  In Nigeria, Togo, and the Cameroons, a cowpea storage method for African farmers was tested. Grain is placed in plastic bags along with a capsule of CCl_4. A one-year trial showed no changes in the level of damage in treated cases. Germination is not affected and nutritionally, the composition of the stored peas is the same as freshly harvested ones.

- STANTON, W.R., ET AL, 1966, Grain Legumes in Africa. FAO, 183 pp.

  This publication deals primarily with cultivation practices, breeding and nutritive value of grain legumes in traditional African diets. One section deals with pre and post-harvest pests and their control and storage of grain legumes in Africa.

(ii) Structures

- O'DOWD, E.T., 1971, Hermetic Storage of Cowpeas (Vigna un uiculata, Walp) in Small Granaries, Silos and Pits in Northern Nigeria. Samaru Misc. Paper (31) 1-3, pp 1-38.

  Hermetic storage of cowpeas using plastic liners was tested in:
  1) weldmesh silos of 500 kg. capacity;
  2) 1-ton capacity galvanised iron silos;
  3) reinforced dried earth granaries;
  4) small underground pits;
  5) normal dried-earth granaries.

  Best results were obtained with traditional dried earth granaries of 150 kg. capacity lined with plastic. The expense put silo storage out of reach to the farmer and pit storage was not suitable. The study also discusses

penetration trials of plastic liners by the adults of the insect Callosobruchus maculatus. They found that penetration could be stopped by a cloth or jute liner inside the plastic liner. Complete elimination of insects was rarely achieved, but damage to hermetically stored cowpeas did not increase.

(iii) Protection

- CORNES, M.A. & ADEYEMI, 1969, A Comparison of Phosphine and Ethylene Dibromide for the Fumigation of Cowpeas in Polythene-lined Hessian Sacks. Bull. Ent. Soc. Nigeria 2 (1) pp 45-50.

  The effectiveness of phosphine and ethylene dibromide for fumigation of cowpeas in polythene bags is compared. Phosphine gave good control of Callosobruchus maculatus (L) in both adult and pre-adult stages. Ethylene dibromide gave only partial control.

- MITAL, H.C., 1971, Protection of Cowpeas from Insect Infestation with the Aid of Fixed Oils. J. West Afr. Sci. Assoc. 16 (1) 45-8.

  Samples of local cowpeas in Ghana were dried and cleaned and treated with coconut, groundnut and oil palm oil and stored at room temperature, together with, and without, insect infested cowpeas, over a 6-month period. Oil treatment gave full infestation protection, but made the beans unviable, although suitable still for human consumption.

- NISA, M. & AHMED, H., 1970, Laboratory Evaluation of Organic Insecticides Against Pulse Weevils in Stored Chickpeas. Int. Pest Control 12 (5) p. 17.

  A series of tests were conducted to determine satisfactory protection of chickpeas against the pulse weevil, Callosobruchus analis F. Lindane dust was found to be the most effective compared to methyl parathion, dimethoate, malathion and carbonyl.

- WEAVING, A.J.S., 1970, Susceptibility of Some Bruchid Beetles of Stored Pulses to Powders Containing Pyrethrins and Piperonyl Butoxide. Pyrethrum Post 10 (4) p.17-21.

  In Kenya, laboratory trials were conducted to determine the susceptibility of the beetles Acanthoscelides obtectus, Zabrotes subfasciatus, and Callosobruchus chinensis to pyrethrins, and to establish factors of synergism for these insects, using piperonyl butoxide as the synergist. It is suggested that a 0.2% pyrethrins powder of 1:10 to 1:15 synergist ratio, applied to give 2 ppm of pyrethrins, would be suitable for practical control of A. obtectus and Z. subfasciatus. A 0.2% pyrethrins powder with a 1:15 synergist ratio, already marketed, could also be expected to give good control at the 2 ppm pyrethrins level, assuming that "knock-down" is sufficient to prevent reinfestation. The latter assumption was supported by small-scale infestation tests.

5. Storage Economics

- ANTONIO, Q.B.O., 1962, WASPRU/UCI Grain Storage Project 6. The Economics of Cowpea Storage in a Concrete Bin. WASPRU Ann. Rep. pp 94-95.

  Costs are given for the storage of cowpeas, broken down into depreciation, chemicals for fumigation, electricity and labour.

D. Export Markets

- EXPERIENCE INC., 1972, Feasibility of Producing Pulse Crops for the Export Market.

- FRUIT TRADE JOURNAL, 1969, Growing Impact of Africa on Luxury Market, 135 (1), p. 15.

  The article simply notes that in early 1968, Niger began exporting French beans on a trial basis to Paris and London via passenger airliner and that these shipments are now being carried out on a regular basis.

- FRUIT TRADE JOURNAL, 1969, Ethiopia Set for Produce Export Expansion, 136 (45) p. 11.

  A very brief and general article concerned with the export of French beans and other crops from Ethiopia. It notes that special charter aircraft were used to export these crops for the first time in 1968. A cold store and pre-cooling plant at the shipping point, recently opened, is seen as a significant improvement in East African export trade.

- FURIA, R. di, 1970, Etude sur les Possibilitées de Developement de l'Exportation des Fruits et Legumes du Sénégal. FAO, AGS:SF/SEN 5, Rap. Particulier, SEN-205/No. 31, 25 pp.

- GOERING, T.J., ET AL, 1972, The Response of Ethiopian Farmers to Changes in Product Prices. Ethiopian Observer, 15 (3) pp 154-62.

  Estimates of export supply response to changes in prices for 10 agricultural products showed that in general, there is a 2-year supply lag on price. For 8 of the 10 products, a positive price responsiveness was established. These 8 included pulses. The author feels that there is most likely a general price responsiveness for most agricultural products for export and internal markets.

E. Utilisation

1. Traditional Processing and Nutritional Assessment.

- AMERICAN CHEMISTS Abstract, Oct. 20, 1935, Use of Teff Flour etc. and Cultivation in Ethiopia 29 p. 6959.

- AYKROYD, W.R. & DOUGHTY, J., 1964, Legumes in Human Nutrition, FAO Nutritional Studies No. 19.

  Common names and areas of cultivation are given for many species of legumes. A survey of the importance of pulses in diets of various populations is reviewed. Comparisons of composition and nutritive values of pulses in comparison with other protein foods are arranged in table form. One chapter is devoted to methods of processing and cooking, including fermentation methods, and another on some toxic substances found in legumes.

- DOUGHTY, J. & ORRACA-Tetteh, 1966, The Contribution of Legumes to African Diets. Grain Legumes in Africa. FAO.

- FAO, 1958, Technical Meeting on Legumes in Agriculture and Human Nutrition in Africa. FAO/CCTA, 10 Nov. 1958. Held at Bukawu, Belgian Congo - section on storage by D.W. Hall, also methods of preparation and cooking.

- GEURTS, F., 1961, Legumious Food Crops Other Than Groundnuts in Ghana. Faculty of Agric., Univ. of Ghana, Dept. Paper.

- GIORNALE DI RISICOLT, 1937, Composition of Teff and its Flour Compared with Wheat. 27 pp. 19-21.

- HOLM, H.M., 1956, Cultivation, Sowing, Harvest, Yield, Use for Bread ("ingera"). For. Agric. Ser., U.S.D.A., Ethiopia. pp 16-17.

- JANSEN, G.R. ET AL, 1962, Analysis of 6 Samples of Teff for Their Amino Acid Content. Results of rat-feeding exp. with teff and with lysine supplemented teff. J. Agric. Fd. Chem. 10 (1) pp 62-4.

- KOPP, E. & WUHIB, E. Injera. Recipe for the preparation of Injera: Unpublished Report. Ethiopian-Swedish Nutrition Unit, Addis Ababa.

- OMUETI, J.O. & OYENUGA, V.A., 1975, Rat Utilization of Organic Iron from Cowpea and Groundnut in: Proceedings International Congress of Nutrition 9th (V.1) 157-163.

- OWUSU-DOMFEH, K., 1972, Trypsin Inhibitor Activity of Cowpeas (Vigna unquiculata) and Bambara Beans (Voardzia subterranea). Ghana J. Agri. Sci. 5 (2) pp 99-102.

  Experiments in Ghana showed that cowpeas inhibit trypsin by 20-19% and bambara beans by 58-11%. It was also shown that heating of cowpeas and bambara beans increases the digestibility of the nutrients and the protein utilisation of both legumes.

- PARPIA, H.A.B., 1973, Utilisation Problems of Food Legumes. Nutritional Improvement of Food Legumes by Breeding. P.A.G.

- RACHIE, K.O. & WURSTER, R.T., 1971, The Potential of Pigeon Pea (Cajarus cajar, millsp.) as a Horticultural Crop in East Africa. E.African Horticultural Symposium, pp 172-8.

  The pigeon pea, its history in Kenya, Uganda and Malawi, its importance as food, the food value and the processing techniques of the bean are outlined. Kenya exports tinned pigeon peas. In Malawi, breeding selection and agronomic

studies are being undertaken. A type collection of over 5,500 strains has been gathered. Short descriptions of the major diseases and pests of pigeon peas are presented.

- ROUK AND HAILU MENGESHA, Undated, An Introduction to Teff, a Nutritious Cereal Grain of Ethiopia. Imp. Ethiopian Coll. Agric. Mech. Arts; Exp. Stn. Bull. No. 26.

- SIEGEL, A., 1975, Food Legume Processing and Utilisation, with special emphasis on application in developing countries. IDRC, Canada 107 pp.

- SMIRL, C.A. & ZOAKA, L., 1974, Consumer Preference for Cowpeas in Maiduguri, Maiduguri Pilot Flour Mill, Min. of Nat. Resources, N.E. State, Nigeria, 49 pp.

- STANTON, W.R., 1962, Northern Nigeria, Min. of Agric., Ann. Rep. (Research and Specialist Services), p. 12.

  The paper reports of the continuing national survey of distribution, agronomic practices and domestic use of grain legumes. Cowpeas (Vigna sinensis) is the major indigenous grain legume, and is found almost everywhere north of the 8th parallel. Other crops reported were:
  1) Phaseolus lunatus - grown as a compound crop in Southern Zaria, Plateau Benue, Ilorin and Kabba Provinces.
  2) Green yam (Phasealus aureus) restricted distribution.
  3) Underground cowpea (Kestingiella) only in Southern Zaria.
  4) Yam bean (Sphenostylis, sp.) only Riverain Provinces.
  5) Pisum (Canavallia and Casseatora) were reported known or cultivated.

- STEWART, R.B. & GETACHEW, A., 1962, Investigations of the Nature of Injera. Economic Botany 16 (2) 127-30.

  A description of the traditional methods of preparing njera (bread) from teff in Ethiopia is presented. There are 3 types of njera, classified according to the amount of fermentation undergone by the dough-paste. A study was conducted to determine the process by which teff is fermented for njera. The primary agent of fermentation was identified as Candida guilliermondii (cast.) (Longeron and Guerra). The manner in which this yeast is passed from batch to batch is noted.

- U.S., 1956, Teff. Foreign Agric. Services, U.S.D.A., Ethiopia, pp 16-17.

  A very brief description of teff cultivation and use in Ethiopia. Teff is harvested by hand, sheaved and stacked. Most teff is ground into flour on hand-operated stone mills, but a few mechanical mills exist. The national bread is njera, for which teff flour is preferred, although wheat flour is making inroads. The traditional bread is a soft unleavened dough made into thin 18-inch diametre cakes and baked chiefly on a griddle, oven or fire. Only green teff is used as fodder.

2. Modernised

(i) Milling

- KHARE, R.N. ET AL, 1966, Milling Losses of Food Grains. Part I. Studies on losses of red gram during milling. Bull. Grain Tech., India 4 (3) pp 125-32.

  The paper describes the methods of processing pigeon pea grain in a mill in Uttar Pradesh. The nature of the various products and by-products and their proportion in a 3-ton trial run, are tabulated. Actual output of flour from the mill was 76.1%, 8.6% lower than expected and 10% was unfit for food. Explanations for this are given, including faulty rollers and shellers, uneven tempering, cracking from sun drying, rats, birds and storage insect damage. Recommendations for overcoming these problems are made.

- KURIEN, P.P. & PARPIA, H.A.B., 1968, Pulse Milling in India. I. Processing and milling of Tur Arhar (cajanus cajan). J. of Food Tech. 5 (4) pp 203-7.

  The method of processing tur to make dahl (flour) is described, along with the efficiency, difficulties and deficiencies of the industry.

- KURIEN, P.P. & PARPIA, H.A.B., 1969, Improved Methods for Milling of Pulses for Higher Outturn. N.U.-P.A.G. document 2.29/5, 6 pp.

- SHEHARU, N.A. & FRYER, B.A., 1970, Effect of Chickpea Flour on Protein Quality. Cereal Chem. 47 (6) 663-70.

(ii) Bread

- BORGATTI, G., 1937, Nutritive Value of Teff in Man. Bull. Soc. Ital. Biol. 12 pp 677-680.

  Bread made from Ethiopian teff was found to be low in nutritive value, due to poor protein utilisation and the fact that a palatable bread is difficult to bake from it.

- GIORN. DI RISICOLT, Feb. 28, 1937, Study of Teff in Bread-making. 27, pp 19-21.

(iii) New and Modified Uses

- BENDER, A.E., ET AL, 1968, Evaluation of Novel Protein Products. Proceedings of the International Biological Programme and Wenner Glen Centre Symposium, Pergamon Press, Oxford and New York.

  The symposium covered a number of areas dealing with protein supplementation of diets, principally in tropical countries. The first session gives a general overview of the world protein situation, including the potential of food science technology as related to food habits and taboos in developing areas. Novel protein sources are reviewed, including one paper on high-protein cereals. Two sessions are devoted to protein quality evaluation

and a further one to functional evaluation. Another session deals with the effect of processing and storage on the value of protein. Although most of the papers deal with modern scientific and technological areas, the developing tropical regions are constantly kept in view. Much of the symposium is concerned with animal protein sources, but considerable attention is also paid to cereal and legume protein.

- FAO/UNDP, 1973, Sales of Baby Food in Dar Es Salaam. Mktg. Dev. Bureau., Min. of Agric., Dar Es Salaam, FAO/UNDP Project SF TAN 27, Report No. 27.

- FURIA, R. di, 1969, The Processing of an Infant Food in Senegal. RU-UNDP/SF SEN/5, pp 30. RESTRICTED.

- KANSAS STATE UNIVERSITY, Manhattan Food and Feed Grain Inst. 1972, June 1, Improving the Nutritive Value of Cereal Based Foods.

  The study reviews research into improving nutritional values of cereal foods in North Africa and Pakistan by protein supplementation, and process modifications which did not detract from the acceptability of the food to local consumers. Soy, chickpea and broadbean flour was added as a protein supplement to wheat based bread, chapatis and cous cous. Besides meeting the nutritive guidelines set for the project, these foods proved acceptable to small consumer taste panels. Other protein sources were also evaluated, and a system of developing and evaluating protein fortified foods was evolved.

- KAPSIOTIS, G.D., Aug. 1966, Development of the Algerian Weaning Food Mixture, P.A.G. Meeting, Geneva, Nutrition Document R.10/Add 93.

  The weaning food mixture consists of 45% chickpea flour, 35% wheat flour and 22% lentil flour. The legumes were washed and decorticated at the SEMPAC pasta plant in Bhidu, Algeria, and yielded 75-80% for chickpeas and 65% for lentils. The wheat fraction used was the very fine semolina, which proved half the cost of the other fractions. A description is given of the processing of the weaning food from a pasta dough and a chemical analysis of the final product is outlined. Storage and packaging trials are being carried out at T.N.O., The Netherlands. Results of feeding trials in Algeria proved satisfactory and showed a definite anti-diarrhoeal quality. A short note on the cost of this product mentions that it is about ¼ the cost of commercial weaning foods. A pilot plant is proposed to further test the process and product.

- KORTENHORST, L.F., & CROWLEY, M., 1964, Grain Legumes for Improved Human Nutrition. F.F.H.C., No. 4, Nigeria (Restricted).

- KOUTHON, G.D., 1972, Technological Aspects of Protein Foods produced in Developing Countries. Food and Nutri. Africa (11) pp 9-17.

  This paper reviews the technological aspects of producing protein foods from conventional and unconventional protein sources. Discussion on preparation of foods from combinations of vegetable protein sources as well as fish and single cell proteins are presented. The problems involved in producing protein foods in developing countries are examined.

- PARPIA, H.A.B., 1967, Some Technical and Economical Considerations for the Manufacture and Marketing of High Protein Foods. Symposium on Protein Foods and Concentrates, C.F.T.R.I., Mysore.

- SAINT-HILAIRE, S., 1962, Pulses and Fish. Seminaire de Nutrition, Porto-Nova, Dahomey 2 pp 285-95.

- SAVINA, J.F., 1968, Development, Processing and Distribution of "Supro" in Kenya. NU-FAO/WHO/UNICEF.

- SIEGEL, A., 1975, Processed Legumes by New Technologies, presented at Cowpea Network Meeting, Household Processing and Utilisation in West Africa, Ibadan, Nigeria, Nov. 5-7, 23 pp.

- STEFANOVIC, R., 1968, Development of a High-Protein Infant Food in Senegal. FAO/WHO/UNICEF, PAG Sept.'68 Meeting, Rome, Document 3/38, 9 pp.

  A brief history of "Ladylac", a weaning food produced in Senegal from 45% milled cous cous, 15% defatted groundnut flour, 20% skimmed milk powder and 20% sugar is given. The failure of the product on the market was attributed mainly to natural lack of acceptance of pre-manufactured goods and to price. A new formula using a pasta rather than a cous cous as a bsis is to be attempted. The formula consists of 20% sorg. or millet, 50% cowpeas, 20% powdered milk and 10% sugar. The resulting product is 60% cheaper than "Ladylac."

- STEFANOVIC, R., 1973, Un Mélange de Légumes en Conserve d'Intérêt pour une Production Industrielle au Sénégal. Rap. No. 111, 7 pp.

- WILKIE, N.A., 1968, The Introduction and Promotion of Superamine in Algeria. NU-FAO/WHO/UNICEF, PAG 68, 7 pp.

(iv) Packaging

- MACARTNEY, J.C., 1966, The Selection of Haricot Bean Varieties Suitable for Canning. East Afr. Agric. For. J. 32 (2) pp 214-19.

  Selecting haricot bean varieties conforming to agronomic and marketing requirements is described. A test was carried out on the effect of humidity on storage. Fifty-two agronomically suitable varieties were stored

in a well-ventilated seed store at Tenegeru during 1963. 2 lb. samples of each type were bagged and soakability tests carried out on two replicates of 100 seeds at monthly intervals. The relationship between monthly minimum percentage of relative humidity and percentage hard seed of three Tenegeru selections are graphed. Main commercial requirements are that:

1) the seed should soak 100% when left in tap water for 16 hours, and
2) suitable size, shape and flavour for canning.

- MAYER, E.L. & NELSON, H.D., 1955, Fumigation of Dry Beans and Cowpeas on the Packaging Line. U.S.D.A. Agric. Marketing Services. Bull. No. AMS-4.

  It was found that a small measured amount of fumigant added to the filled package of retail peas or cowpeas just prior to sealing was needed to prevent infestation, developing from insect eggs accidentally included in the package. Thirteen fumigants and mixtures of these, including: acrylonitrile, carbon tetrachloride, ethylene bromide and methyl bromide were tested on cellophane bags. Effective dosages of selected fumigants ranged from 0.2 to 0.3 ml per bag. Taste tests demonstrated no change in the flavour of cowpeas.

- SIDDAPPA, G.S., 1959, Canning of Dried Bengal Gram (Cicer arietinum). Indian J. of Horticulture 16 (3) pp 170.

  It was found that the green colour of the dried green Bengal gram was lost during the blanching and canning processes. Various trial procedures for correcting this problem are discussed. It was found also that certain canning processes caused a mucilaginous product and attempts are made to explain the reasons for this. An alternative process, which gives a non-mucilaginous product is described.

- SIMMONS, E.A. & RILEY, J., 1968, An Assessment of Various Packaging Materials for Packaging Cowpeas. Tech. Rep. Nig. Stor. Prod. Res. Inst., No. 14.

  Paper/polythene laminates gave protection against entry of C. maculatus from infested cowpeas in contact with the package; polythene and polythene/cellulose laminate did not, but these materials gave effective protection against full adult C. maculatus.

3. Animal Feeds

- SHONE, D.K., 1961, Toxicity of the Jack Bean. Rhodesian Agric. J. 58 (1) pp 18.

  A review of the literature on jack bean toxicity is given. The study reported in this paper determined that 1 oz. of seed per 1.62 lbs. of body weight fed for 3 days would be lethal. Symptoms of poisoning and the results of post-mortem examination are given. The study recommends that jack bean meal should be limited to 30% of the total ration, or that it should be heat treated first. Caution is advised wherever jack bean herbage, pod or seed meal is fed to livestock.

APPENDIX

Publications to be Released in the Near Future

- BELSHAW, D.G.R. & KEMPE, M.E., A Comprehensive Bibliography of Rural Development Research in Tropical Africa. Inst. Dev. Stud., U. of Nairobi

- FAO, Composite Flour Programme, Documentation Packages, Vols. II and III., FAO, Rome, will include:
  - papers given at two meetings of the ICC on composite flours.
  - papers given at a symposium on composite flours in Bogota, 1972.
  - annotated bibliography on composite flours, Trop. Prod. Inst.
  - proceedings of a conference on the use of non-wheat flour, Trop. Prod. Inst.

- FAO, Use of Sorghum in Sudan, Food Res. Inst., Khartoum.

- HAMILTON, A.G., 1975, Botswana, A Study of Post-Harvest Technology in Semi-Arid Regions of Africa. CUSO, Univ. of Alberta, Canada.

- HAYWARD, Crop Storage in Somalia - Agriculture Development Corporation. Project: Somalia 66/507. A work on hermetic, underground storage.

- INST. OF FOOD TECHNOLOGY, Dakar, Two Final Reports of the Joint FAO/ITA Projects in Senegal and Niger. Possibly available by the end of 1974.

- KILLICK, T., Bibliography of Agricultural Research in Kenya, University of Nairobi

- UNDAT, Etude de la Production et de la Commercialisation des Céréales au Tchad. UNDAT Mission, 1973.